1971

An economic feasibility study of extension of the Seattle monorail to connect directly to the Seattle Center parking garage.

Schierman, Eldon C.
University of Washington

AN ECONOMIC FEASIBILITY STUDY OF EXTENSION OF THE SEATTLE MONORAIL TO CONNECT DIRECTLY TO THE SEATTLE CENTER PARKING GARAGE

ELDON C. SCHIERMAN

AN ECONOMIC FEASIBILITY STUDY OF EXTENSION OF THE SEATTLE MONORAIL TO CONNECT DIRECTLY TO THE SEATTLE CENTER PARKING GARAGE

By

ELDON C. SCHIERMAN

A thesis submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN CIVIL ENGINEERING

UNIVERSITY OF WASHINGTON

1971

AN ECONOMIC FEASIBILITY STUDY OF EXTENSION
OF THE SEATTLE MONORAIL TO CONNECT DIRECTLY TO THE
SEATTLE CENTER PARKING GARAGE

by

ELDON C. SCHIERMAN

A thesis submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN CIVIL ENGINEERING

UNIVERSITY OF WASHINGTON

1971

Approved by ______________________________
(Chairman of Supervisory Committee)

Department ______________________________
(Departmental Faculty Sponsoring Candidate)

Date ______________________________

In presenting this thesis in partial fulfillment of the requirements for a master's degree at the University of Washington, I agree that the Library shall make its copies freely available for inspection. I further agree that extensive copying of this thesis is allowable only for scholarly purposes. It is understood, however, that any copying or publication of this thesis for commercial purposes, or for financial gain, shall not be allowed without my written permission.

Signature________________________

Date____________________________

ABSTRACT

In the body of this report, it is shown that an extended monorail and a third passenger terminal can be constructed for an estimated total cost of $955,000.00. It is anticipated that the proposed system will generate an annual income of $194,625.00 per year as compared to an additional annual maintenance and operating cost of $149,500.00 per year. It is suggested that some (up to two-thirds of the total) of the capital cost of the extension may be deferred by means of a federal grant under one or more of several available federal programs. Assuming a federal grant of $636,667.00, or two-thirds of $955,000.00, the resulting annual cost of bond retirement would most likely fall between $23,124.00 and $32,422.00 per year, depending upon the interest rate and length of bonding. In a following section, calculations are conducted for annual interest rates of 6, 7, and 8 percent and bonding periods of 20, 25, and 30 years. The resulting B/C ratios (assuming two-thirds federal assistance) range between 1.070 and 1.128 (see Table IX, page 90.)

From the nearly one million dollar investment discussed above, an addition of 1000 parking spaces to serve the Seattle CBD is realized. This results in a cost of approximately $1000.00 per space, which is cheap for a metropolitan CBD area by almost any standard.

For a total monthly charge of $13.75, an estimated 1000 commuters will be attracted to the Seattle Center Garage to park and ride the Monorail to work downtown. An additional 300 car-pool riders will also arrive at the garage and, thus, be obligated to ride the Monrail downtown. Their fare will amount to $7.00 per month per rider.

The extended Monorail will operate with six minute headways in each direction during the peak commuter periods; i.e., 7:00 to 9:00 am and 4:30 to 6:30 pm. Train capacity during these periods is 1240 seats and 4500

total passengers per hour in each direction. The travel time between stations is 2 minutes and 5 seconds, at a top speed of 53 mph, with another 55 seconds reserved for in-station passenger loading and unloading.

The configuration of the proposed Monorail station provides for a reserved bus bay, thus allowing termination of several existing Transit bus routes at the Seattle Center Garage. Transit passengers would then be obligated to transfer to the Monorail for the remaining trip downtown. During the peak commuting periods, approximately 3353 people (2053 bus transfers and 1300 parking commuters) can be expected to ride the Monorail in the peak direction. This figures to an average of 170 passengers per run. Since it is assumed that accumulation of bus riders and parking commuters will not peak at the same time (see discussion, Chapter V), the maximum accumulation during the peak period is estimated at about 300 passengers per run. Thus, during maximum passenger accumulations, it is anticipated that the Monorail may have as many as 175 standees in addition to the 124 available seats.

The discussion of Chapter III presents a detailed analysis of the existing street system in the vicinity of the Seattle Center during the two peak periods. Evidence is presented that east-west access to and from two major corridors; namely, Interstate-5 and Elliott Avenue West, are presently operating at, or near, maximum possible capacity and the superimposing of additional commuters along these routes during the peak periods would be virtually impossible without some sort of changes being made. In the case of Elliott Avenue West, a simple alteration of signal timing at the intersection of West Mercer Place and Elliott Avenue may solve the problem, however, insufficient available data warrants further study of that intersection

before a final recommendation is made. In the case of the route between the Seattle Center and the Interstate-5 freeway, it is concluded that a major street revision is necessary in order to successfully handle the additional assigned traffic. In this respect implementation of the Bay Freeway is highly recommended as a solution to the capacity problem of the corridor in question, for it is a project that has already been authorized, funded, and designed by the city of Seattle.

It is the purpose of this paper to prove or disprove the economic feasibility of a proposal to extend the Seattle Monorail to connect directly to the Seattle Center Parking Garage. Based on available data and assumed conditions as applied, the project proves to be economically feasible with a a B/C ratio of between 1.070 and 1.128 (depending upon the assumed conditions of bonding). It is, therefore, strongly recommended by this author that the proposal as outlined in this report be seriously considered for further study and eventual implementation.

FOREWARD

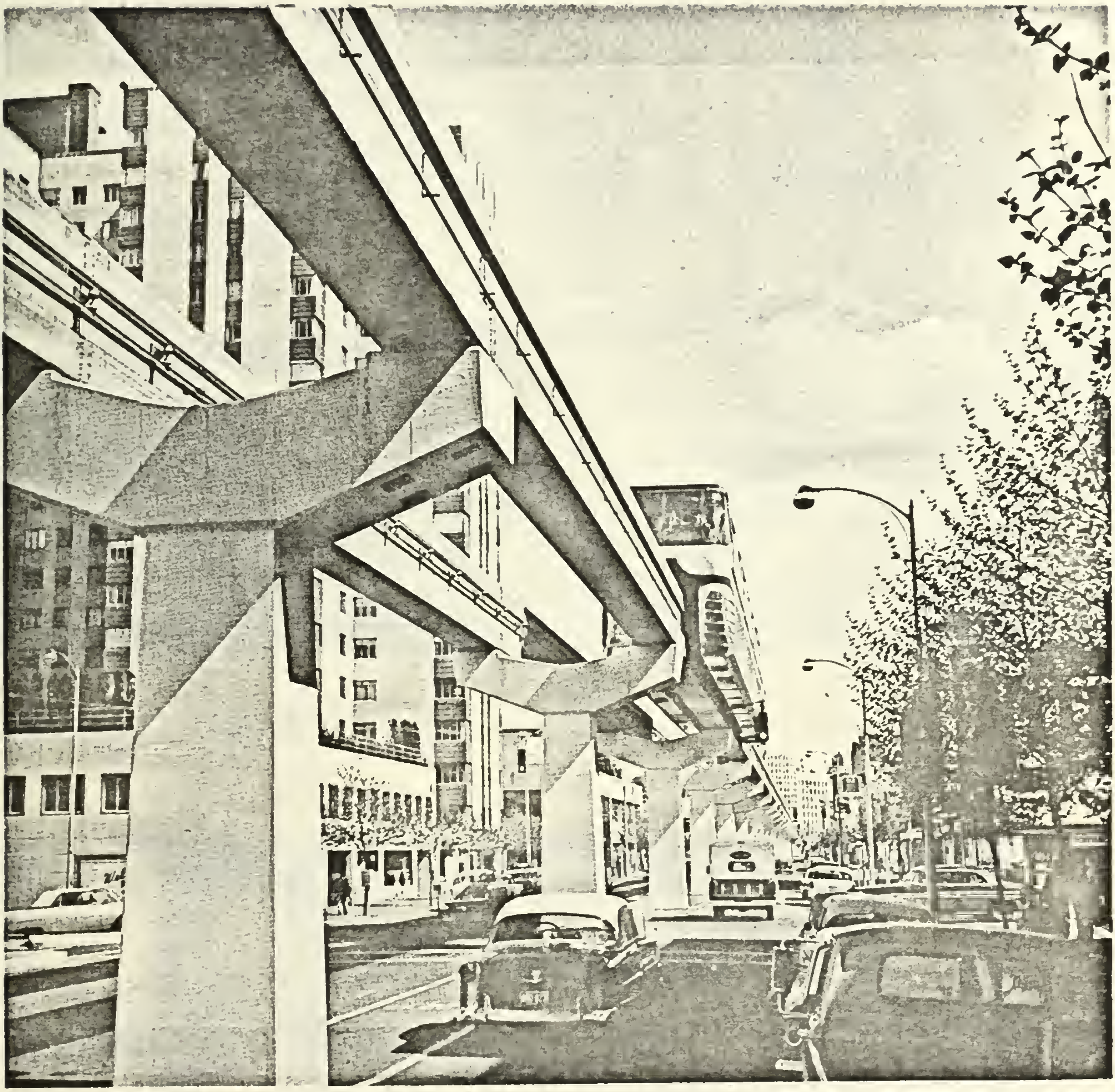
During the spring and summer of 1962, Seattle, Washington served as host city for that year's World's Fair. It was anticipated by the Fair's planners that hundreds of thousands of additional visitors would find their way to Seattle with the singular purpose of visiting the fairgrounds. In order to effectively transport these masses of visitors between the two main centers of activity in Seattle; namely, the central business district (CBD) and the World's Fair, it was concluded that a new form of transit beyond the municipal bus system would have to be installed.

Ten years prior to the Seattle World's Fair, the Alweg Corporation of Sweden began its first experiments on what was to develop as a modern monorail system. [1] In 1957 Alweg built its first practical application of the monorail, a one and one-fourth mile experimental track near Cologne, Germany. This line featured an over-riding monorail train of lightweight cars on rubber tired trucks or bogies. [2] Alweg expanded its efforts to the United States in 1959 when a five-eights scale system was constructed at Disneyland, California, connecting the main grounds with a nearby hotel. [1] The ride in Disneyland became an immediate hit and served to prove the feasibility of the monorail as a transit system to those municipal planners in the United States who maintained interest in mass transportation.

Such was the state of the art in the early 1960's when plans were first being formulated in Seattle for the World's Fair. In keeping with the Century - 21 theme of the Fair which placed the accent on modern technology, the Alweg monorail was chosen to fill the special need for transportation to serve the Fair. A 1.2 mile, twin rail system was designed and constructed at a cost of about two and a half million a mile, connecting the Seattle World's Fair with downtown Seattle at the intersection of Westlake Avenue and Pine Street. Two identical trains, each consisting of two cars, traveled on

the elevated monorails, with passenger stations located at each end of the line. The monorails were completely separate from each other (except for the T-shaped supporting piers) with no connecting loops or switches. The trains, which were built in Europe, were dual-ended in that an operator's control console was located at each end. A round trip actually consisted of reversing the direction of a train over the same rail for the second half of the journey. Figures 1 and 2 give several views of the Alweg monorail as it operated in Seattle in 1962.

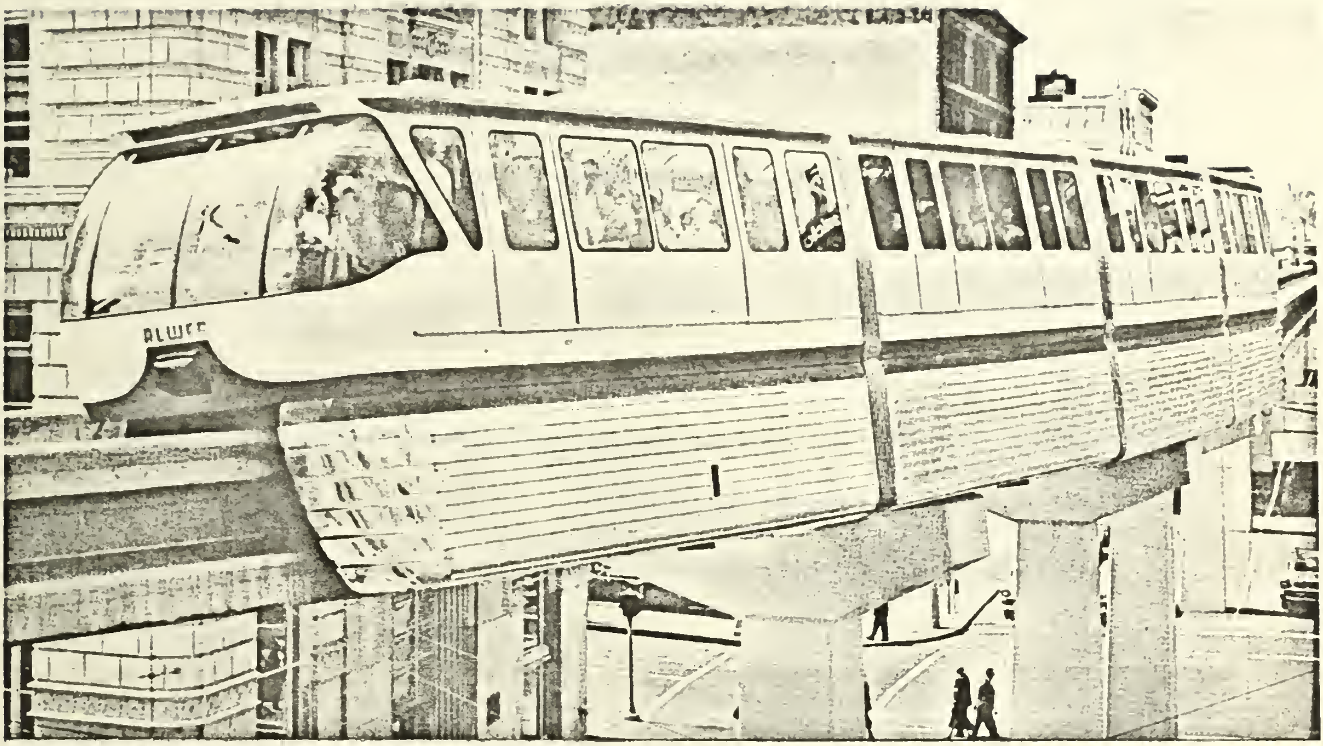
At the close of the Fair in 1962, the City of Seattle began to acquire many of the permanent structures that formed the heart of the Fair, and to develop from these a civic and cultural arena known as the Seattle Center. Although the City had assumed the responsibility for maintenance of all the grounds from the on-set of the Fair and had owned several of the attractions right from the start, ownership of many of the major buildings at that time ranged from the State of Washington, who controlled the Coliseum, to the Washington State National Guard, whose former armory was being employed as the Food Circus Building. The federal government held interests in the Science Center and the Seattle School Board wielded control of the Athletic Stadium. Several of the buildings, such as the Space Needle, were privately owned. City acquisition of most of the buildings which form the present Seattle Center began with the Coliseum in 1963 and is continuing at the present day. During the spring of 1965, the Alweg Corporation turned control of the Monorail system over to the City of Seattle, with operational responsibility for the system delegated to the public organization known as Century-21 and maintenance responsibility assigned to the Seattle Transit Company, a municipally owned bus system. Seattle Transit also continued to supply train operators for the Monorail, something that they had been doing



A Monorail Train In Route Along Its Elevated Guide - Seattle, Washington

(photo from, "Alweg Monorail, the fascinating story of the world's most modern transportation system - 1962)

FIGURE 1



The Seattle Monorail

A View Of A Monorail Train's Interior

(photos from, "Alweg Monorail, the fascinating story of the world's most modern transportation system - 1962)

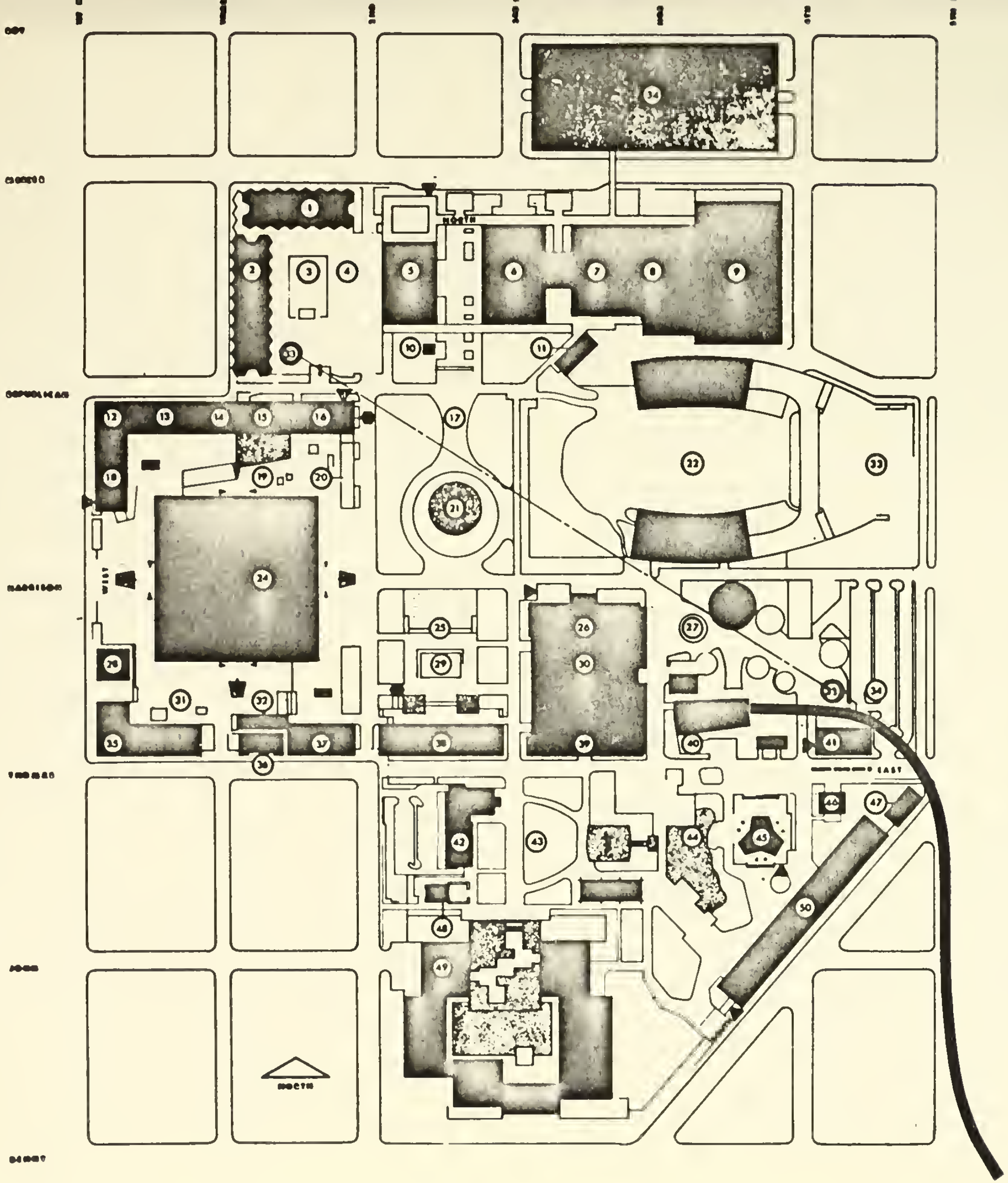
FIGURE 2

under agreement with Alweg since the '62 Fair. Agreement for the transfer of the Monorail was reached on April 30, 1965, with final details being hammered out between the interested parties during the meetings of May 14 and May 20. On January 1, 1966, control of the activities at the Seattle Center shifted from Century-21, a division of the City Building Department, to the newly formed Seattle Center Corporation, a separate department of the municipal government.

Today the Seattle Center has developed into one of the major social centers of Seattle. Activities range from live exhibitions to the performing arts, and from athletic events to general family entertainment. The Monorail continues to operate, mainly as a tourist attraction, between the Westlake Mall station in downtown Seattle and the station at the Seattle Center. Figure 3 clearly illustrates the present layout of the Seattle Center with the major buildings being numbered and labeled.

One major structure which heretofore has not been mentioned is the multi-decked, 1500 car, parking garage. The structure is located to the north, adjacent to the Seattle Center grounds, and is shown as block number 34 in Figure 3. The garage was originally built in conjunction with the Fair to provide parking for Century-21 visitors, and has continued to serve in a similar capacity those people attending shows and events at the present Seattle Center.

Thus, the stage is set for the study which is presented in this report. It is a historical fact that since the Fair of 1962, the Seattle Center parking garage receives little patronage during the day, especially during the winter months when there is little tourist activity at the Center. At night the garage is generally filled with the vehicles of people attending events at the Coliseum or evening shows at the Playhouse, Arena, or Opera



SEATTLE CENTER DIRECTORY

1. Storage Building
2. Storage Building
3. Bandstand
4. Northwest Square
5. Playhouse
6. Exhibition Hall
7. Opera House
8. Display Hall
9. Arena
10. Kobe Bell
11. Veteran's Building
12. Olympic Room
13. San Juan Rooms
14. Nisqually Room
15. Snoqualmie Room
16. Alki Room
17. International Fountain Mall
18. Rainier Room
19. Coliseum North Court
20. Northwest Craft Center
21. International Fountain
22. High School Memorial Stadium
23. Memorial Plaza
24. Coliseum
25. Plaza of the States
26. Administration Offices
    Meeting & Rehearsal Rooms
    Attic Theater (Park Dept.)
27. Fun Forest
28. State of Washington Building
29. Plaza Restaurant
30. International Bazaar
31. Coliseum South Court
32. Maintenance Shops
33. Sky Ride
34. Parking
35. Storage Building
36. 158 Thomas Building
37. Seattle Art Museum Pavilion
38. Flag Plaza Pavilion
39. Food Circus & Show Balcony
    Pottery Northwest Workshop
40. Monorail
    Summer Information Booth
41. Fire Alarm Center
42. Nile Temple
43. Mural Amphitheater
44. Lagoon
45. Space Needle
46. Piccoli Theater
47. Cascade Gallery
48. Covered Rest Area
49. Pacific Science Center
50. Hall of Aviation (S. Section)
    Hall of Fire Engines (Mid-Section)
    Storage (N. Section)

SEATTLE CENTER
SEATTLE WASHINGTON

PAUL THIRY ARCHITECT FAIA

FIGURE 3

House. During the day, however, the structure stands virtually empty. It is, therefore, a logical step to somehow try and make better use of these two major systems by possibly extending the Monorail north to connect directly to the garage. The idea is to encourage people who work downtown during the day to park their cars at the Seattle Center and ride the Monorail to work. Some of the benefits of such a system are obvious, and include reduced auto congestion and pollution in the downtown area, better and more efficient use of an existing parking structure, and integration of the Monorail into the municipal transit system. It is the purpose of this report to present the detailed findings of a study investigating the feasibility of implementing such a plan.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation and gratitude to all the individuals who assisted me in developing the research undertaken and preparing this, the resulting report. Special thanks are extended to the members of my thesis committee; Professor Roy B. Sawhill, chairman; and Professors Robert G. Hennes and Jerry B. Schneider for their guiding assistance throughout the course of this project.

My gratitude is extended to Mr. Charles Barb, Misses Sheila McKinnon and Cathy Hoyer, and the University of Washington Urban Data Center for their diligent assistance in the development, application, and analysis of the Monorail study survey conducted in downtown Seattle.

Other individuals who made a significant contribution to the results contained in this report are: Mr. Frank Whitman of Victor O. Gray and Company, Mr. Dave Hughbanks and Mr. Henry Berg of the Seattle Center Corporation, Mr. Harland Bixby of Howard S. Wright and Associates, Mr. Charles Dolan of Concrete Technologies, Incorporated, Mr. Jerry McGuire of Seattle Transit Company, Mr. Ron Cameron of the City of Seattle Traffic Engineering Division, and Professor Norman H. Roberts of the Department of Mechanical Engineering, University of Washington. I am deeply indebted to all of these individuals for the resources and expertness contributed by themselves and their respective offices.

A special thanks is extended to my wife, Pamela, whose typing and editing assistance and general encouragement throughout the course of the project contributed significantly to my efforts.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

LIST OF FIGURES (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

CHAPTER I

INTRODUCTION

Presently, Seattle is blessed with a reasonably new, 1500 car, four-story parking facility located on Mercer Street, between 3rd Avenue North and 4th Avenue North, across from the Seattle Center. The facility was constructed just prior to, and in conjunction with, the 1962 Seattle World's Fair. It has been retained to provide parking for events taking place at adjacent major Seattle Center attractions, such as the Opera House, Arena, Playhouse, and others. Additionally, it is available during the day as a parking facility for tourists who are visiting the Center in general. Nighttime usage of the facility during periods of major Center activity has proven reasonably successful, however, daytime parking is almost non-existant. Therefore, it should be recognized that a parking facility actually exists which is not being utilized to anywhere near its fullest extent and which has excellent potential to contribute to the relief of the problems created by traffic congestion in the Seattle Central Business District.

There also exists in Seattle a Monorail system, constructed at the same time and for the same purposes (to serve World's Fair visitors) as the parking structure, which connects the Seattle Center and the northern portion of the CBD. It has been retained since the Fair and operates mainly as a tourist attraction or "joy ride." However, even with relatively low patronage volumes, the Monorail has experienced profitable operation over the past several years. Again, it should be recognized that with the Monorail a transit system exists which has the potential of being an important link in the City's public transit system. At the same time, it can be operated profitably while contributing to the solution of Seattle's traffic problems.

The following chapters discuss the results of a detailed investigation conducted by the author during the Spring and Summer of 1971. The purpose of the investigation is to study the feasibility of a proposal for the efficient utilization of the two aforementioned facilities for the fringe area, day-time parking, with a rapid transportation link to downtown Seattle. The obvious benefits of such a system are relief of traffic and parking congestion downtown, possible elimination of some transit buses from the downtown area, some traffic diversion from an already overcrowded Interstate - 5 freeway, and more efficient (and, hence, profitable) usage of existing major facilities.

CHAPTER II

DETERMINATION OF PUBLIC REACTION AND ESTIMATION OF SYSTEM USAGE

A major factor in establishing the feasibility of a Monorail extension proposal is the estimation of the number of people who might be attracted to regular usage of such a facility. The first step taken is identification of the downtown employment population who most likely could be convinced to park their car at the Seattle Center garage and ride the Monorail to their work downtown. Three major assumptions are made which help to establish a total study employment population for use in this investigation. These assumptions are as follows:

A. The people who most likely would be attracted to the proposed system are those individuals who work all day in the downtown area and who also commute by auto. This type of person is considered a long-term parker and is characterized by parking durations of more than four hours. Work trip parking is contrasted to parking for other types of CBD trips, such as business, shopping, entertainment, and others. Parking in conjunction with the latter type of trip is classified as short-term and is generally characterized by a duration of less than four hours.

B. It is further assumed that the maximum acceptable walking distance from the downtown Westlake Mall Monorail terminal to an individual's place of employment is 1000 feet. This figure is somewhat arbitrary but is based upon the results of 1970 Victor O. Gray and Company downtown comprehensive parking study and, also, the author's engineering judgment. Figure 4 shows the north downtown area of Seattle, with circles of 500 foot, 1000 foot and 1500 foot radius around the

Monorail terminal. From these a study area is established which closely approximates the 1000 foot circle. This study area is outlined in Figure 4 and is further illustrated in detail in Figure B-1 on page 124. Data gathered during the summer of 1970 by Victor O. Gray and Company is used to establish the parking habits and characteristics of the people working in the designated study area. The curve in Figure 5 reveals that the median walking distance from parked car to place of work is 750 feet. The figure also shows that 70.52% of the employment population in the study are presently walking 1000 feet or less from their car to their work. Thus, it can be concluded that of the employment population just outside of the study area (greater than 1000 feet from the terminal), only 25 or 30% would save any walking distance by riding the Monorail when compared to their present parking arrangement. As the radius is extended out to 1500 feet, the percent of workers who would benefit, distance-wise, fast diminishes. Therefore, the study area as established (at 1000 foot radius) appears to contain the vast majority of employees who could be attracted to a Monorail park-and-ride system based on a distanced walked criteria. An analysis of the degree of importance that the public seems to place on savings in walking distance (as compared to savings in parking costs, convenience of parking location, etc.) is presented in Appendix B.

C. The final assumption of this study is that only those people who approach the downtown area from the north, northwest, northeast, or east by crossing the Evergreen Point Bridge, can be attracted to

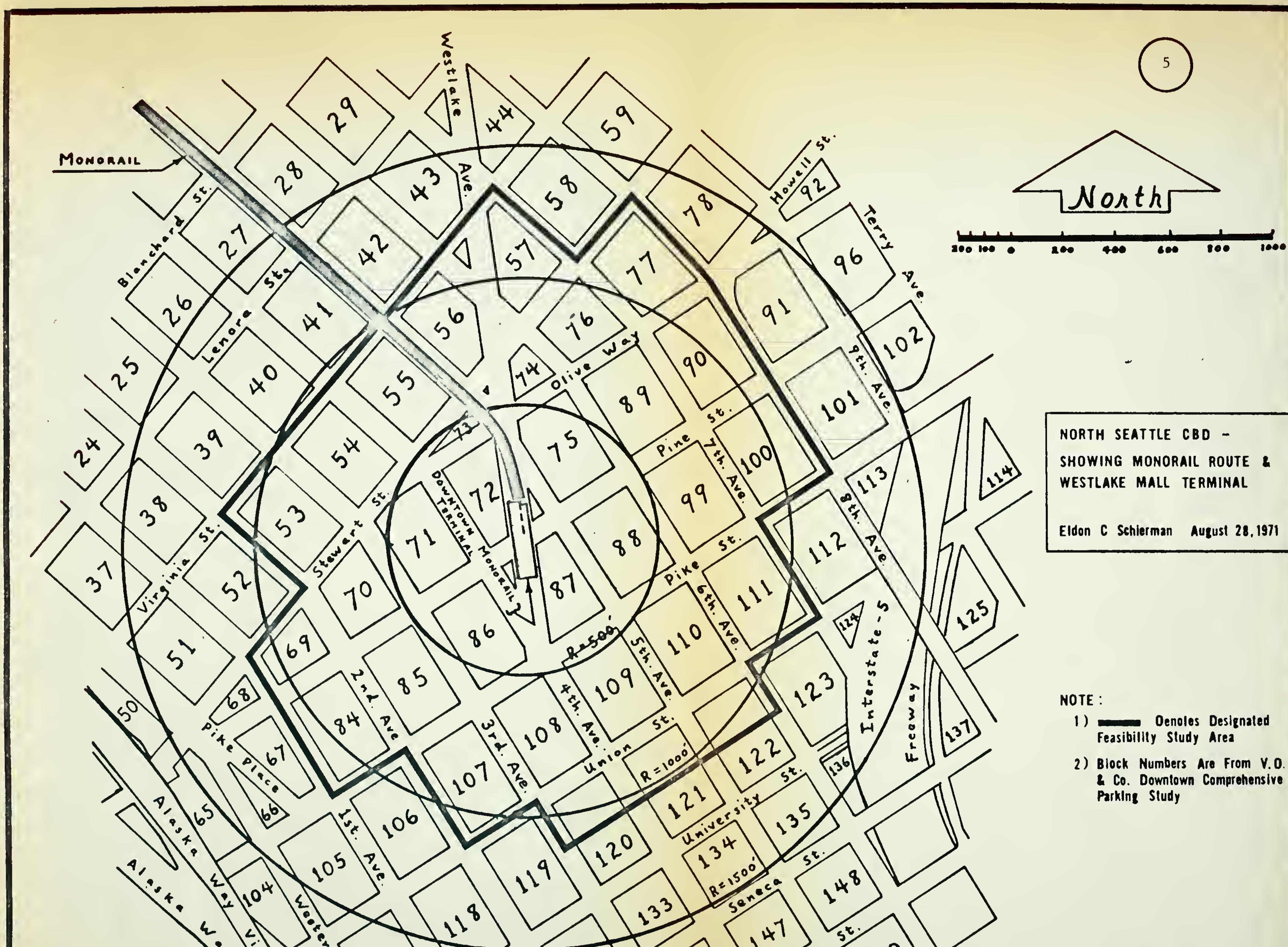
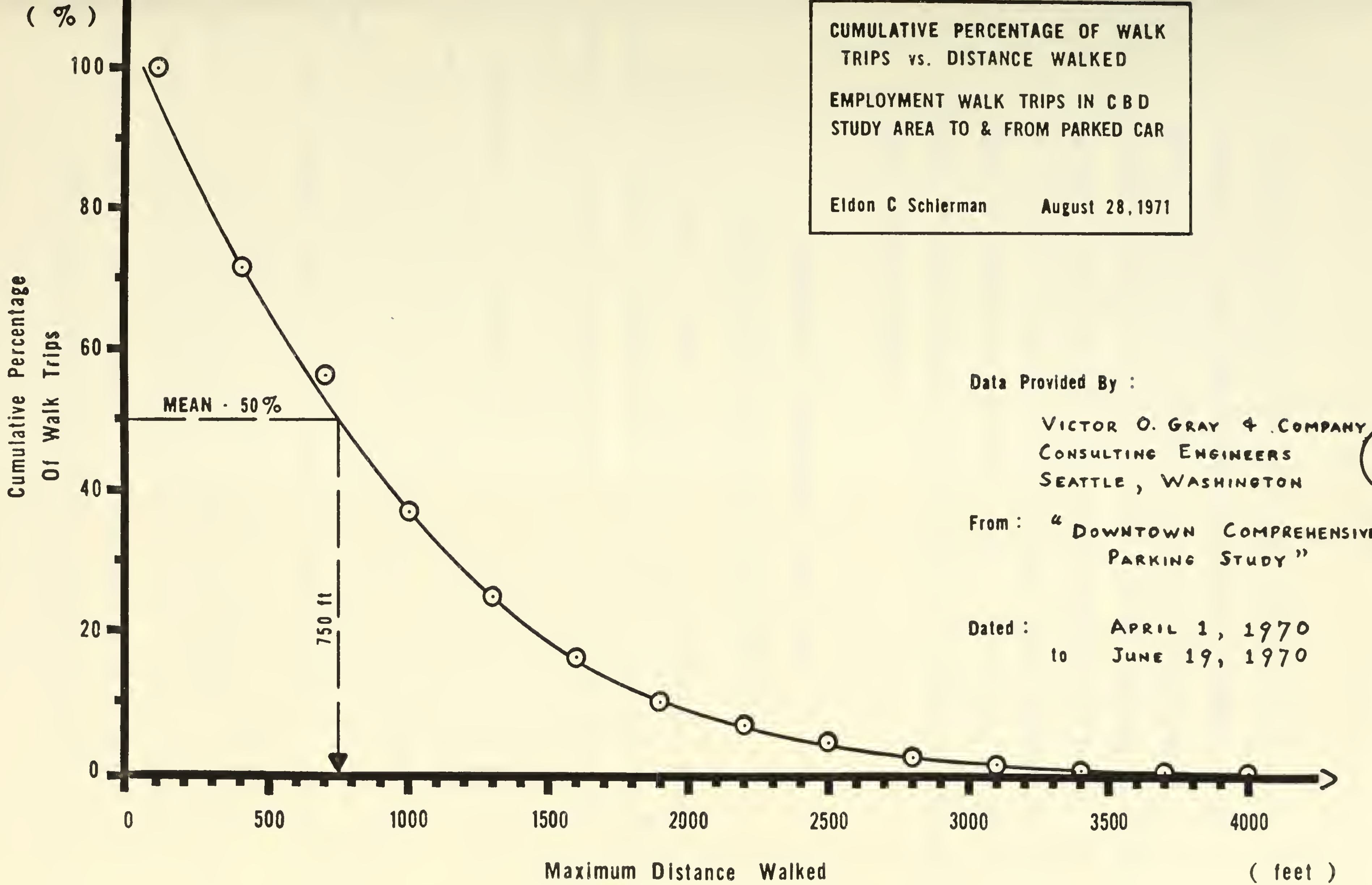

NORTH SEATTLE CBD -
SHOWING MONORAIL ROUTE &
WESTLAKE MALL TERMINAL
Eldon C Schierman August 28, 1971
North
200 100 0 200 400 600 800 1000
NOTE:
1) Oenoles Designated Feasibility Study Area
2) Block Numbers Are From V.O. & Co. Downtown Comprehensive Parking Study
MONORAIL
DOWNTOWN MONORAIL TERMINAL
R=500'
R=1000'
R=1500'
Westlake Ave.
Blanchard St.
Lenora St.
Virginia St.
Stewart St.
Olive Way
Pine St.
Pike St.
Union St.
University St.
Seneca St.
Spring St.
Howell St.
Terry Ave.
9th. Ave.
8th. Ave.
7th. Ave.
6th. Ave.
5th. Ave.
4th. Ave.
3rd. Ave.
2nd. Ave.
1st. Ave.
Western Ave.
Pike Place
Alaska Way Viaduct
Alaska Way
Interstate-5
Freeway

FIGURE 4


CUMULATIVE PERCENTAGE OF WALK TRIPS vs. DISTANCE WALKED
EMPLOYMENT WALK TRIPS IN C B D STUDY AREA TO & FROM PARKED CAR
Eldon C Schierman
August 28, 1971
Data Provided By :
VICTOR O. GRAY & COMPANY
CONSULTING ENGINEERS
SEATTLE, WASHINGTON
From : "DOWNTOWN COMPREHENSIVE PARKING STUDY"
Dated : APRIL 1, 1970
to JUNE 19, 1970
(%)
Cumulative Percentage Of Walk Trips
100
80
60
40
20
0
MEAN · 50 %
750 ft
0
500
1000
1500
2000
2500
3000
3500
4000
Maximum Distance Walked
(feet)

6

FIGURE 5

the Seattle Center area for work trip parking purposes. The majority of these commuters must pass by the vicinity of the Seattle Center anyway via the Interstate-5, Aurora Avenue, or Elliott Avenue West corridors while on their way downtown. Those commuters approaching the CBD from West Seattle, the south, or the east via the Mercer Island Floating Bridge would have to pass by the downtown area, and their eventual destination, in order to reach the Center Garage. The assumption, of course, is that this isn't likely to happen.

ANALYSIS OF THE MONORAIL STUDY AREA EMPLOYER PARKING HABITS AND CHARACTERISTICS

During the summer of 1970, the Victor O. Gray and Company, Consulting Engineers of Seattle, Washington, were contracted by the Seattle Parking Commission to analyze the parking situation in downtown Seattle. The consultants authored three questionnaires which were distributed to employees in the downtown area, questioning them about their mode of transportation to work, their parking habits, and other characteristics of interest.

Questionnaire # 1 was initially distributed as a test survey in the north-central CBD area. Based on the results of this small survey, some of the questions were revised and the resulting questionnaires # 2 and # 3 were distributed to the southern and northern areas of the CBD respectively. Copies of all three questionnaires are contained in Appendix A, along with a complete tabulation of some data supplied by Victor O. Gray and Company from their surveys. For the purposes of this study, only Surveys # 1 and # 3 are of interest, for they alone deal with the employees who work in the

previously designated Monorail study area.

As an initial step in their work, the consultants assigned identifying numbers to each block in the downtown area. The Victor O. Gray numbering assignment is shown in Figure 4 for each block contained in the Monorail study's area of interest. Table I lists the six buildings that were surveyed within the area designated in Figure 4. Additionally, summaries of the data tabulated in Appendix A are presented in Figures 5 through 8. As can be seen from these figures, over half of the workers surveyed (52.68%) drive a vehicle to work in the morning. Another 27.58% ride the bus, while the remaining 19.74% of the employees arrive by one of several other available modes of travel. Also, it is shown that workers park predominately in off-street public facilities (69.36%) and generally pay for their parking by the month (59.96%). From the larger sample of the combined data of Survey's # 1 and # 3, it is seen that over 90% of the workers park their cars for more than 4 hours at a time. A further break-down of parking duration is contained in Survey # 3 which reveals that over 48% of the people park for more than 8 hours while an additional 33 1/3% park for a period between 6 and 8 hours. These characteristics, along with the walking distance curve that was presented in previous discussion, are assumed to be closely representative of the parking and commuting habits of the entire employment population contained in the designated Monorail study area.

LONG-TERM PARKING SUPPLY AND DEMAND, THE EXISTING SITUATION IN THE DOWNTOWN AREA

The Victor O. Gray downtown comprehensive parking study is again used as the source for estimating the total number of long-term parkers who

TABLE I

BUILDINGS SURVEYED DURING THE "DOWNTOWN COMPREHENSIVE PARKING STUDY"

A Study Conducted By: Victor O. Gray and Company
Consulting Engineers
Seattle, Washington

I. Survey # 1

A. The 1411 4th Avenue Building

1. Block # 108 (Bldg. # 72)

2. Date Surveyed - April 1, 1970

B. The Logan Building

1. Block # 110 (Bldg. # 46)

2. Date Surveyed - May 1, 1970

II. Survey # 3

A. The Securities Building

1. Block # 54 (Bldg. # 1054)

2. Date Surveyed - April 7, 1970

B. The Washington Plaza Hotel

1. Block # 56 (Bldg. # 1056)

2. Date Surveyed - June 19, 1970

C. The Medical and Dental Building

1. Block # 75 (Bldg. # 1075)

2. Date Surveyed - April 7, 1970

D. The Tower Building

1. Block # 76 (Bldg. # 1076)

2. Date Surveyed - April 7, 1970

Transportation Modal Split Characteristics:

Employment Trips To C B D Study Area

Eldon C Schierman July 20, 1971

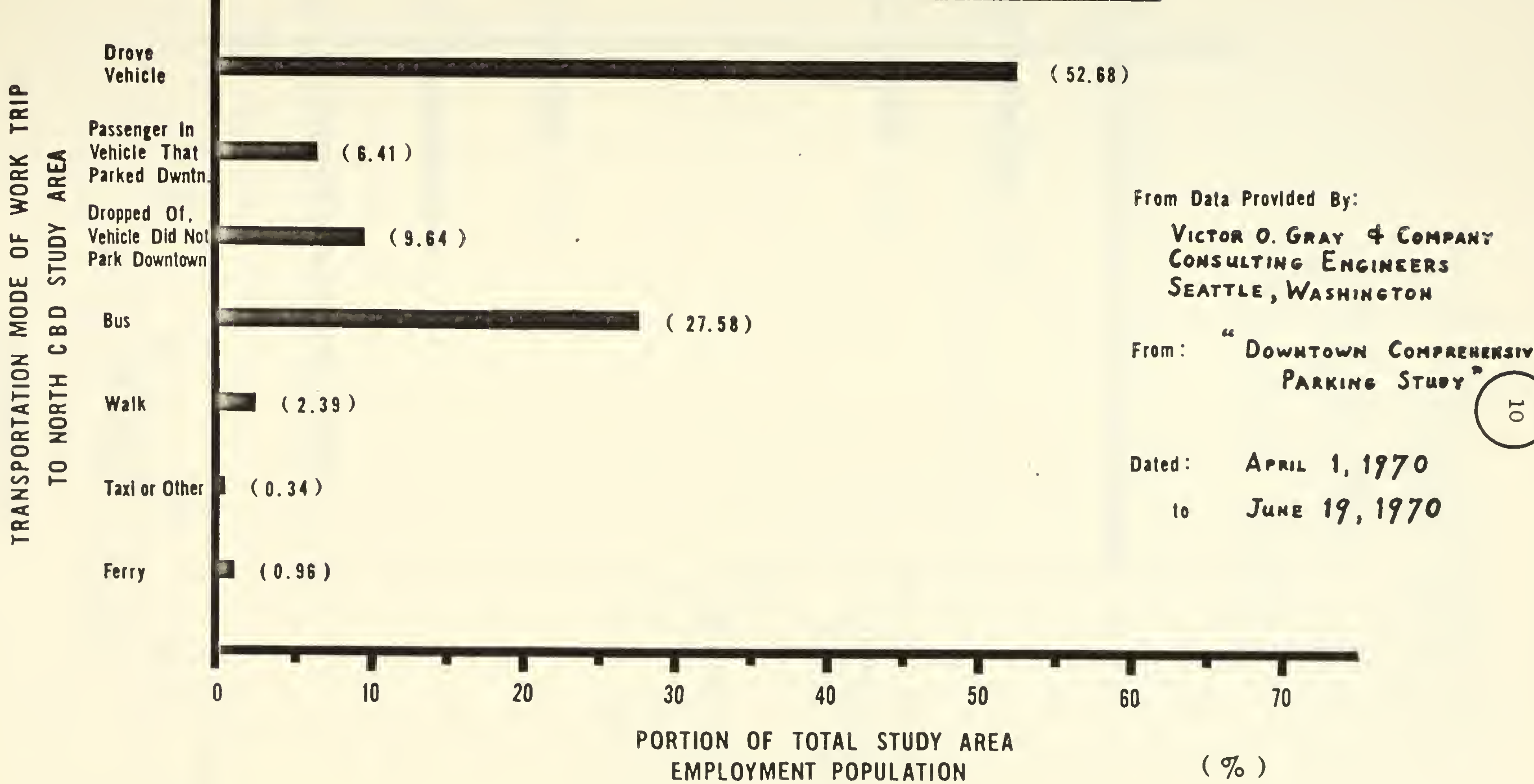


FIGURE 6

Study Area Employment Trip Parking Characteristics:

Parking Payment Schedule And Parking Facility Utilization

Eldon C Schierman July 20, 1971

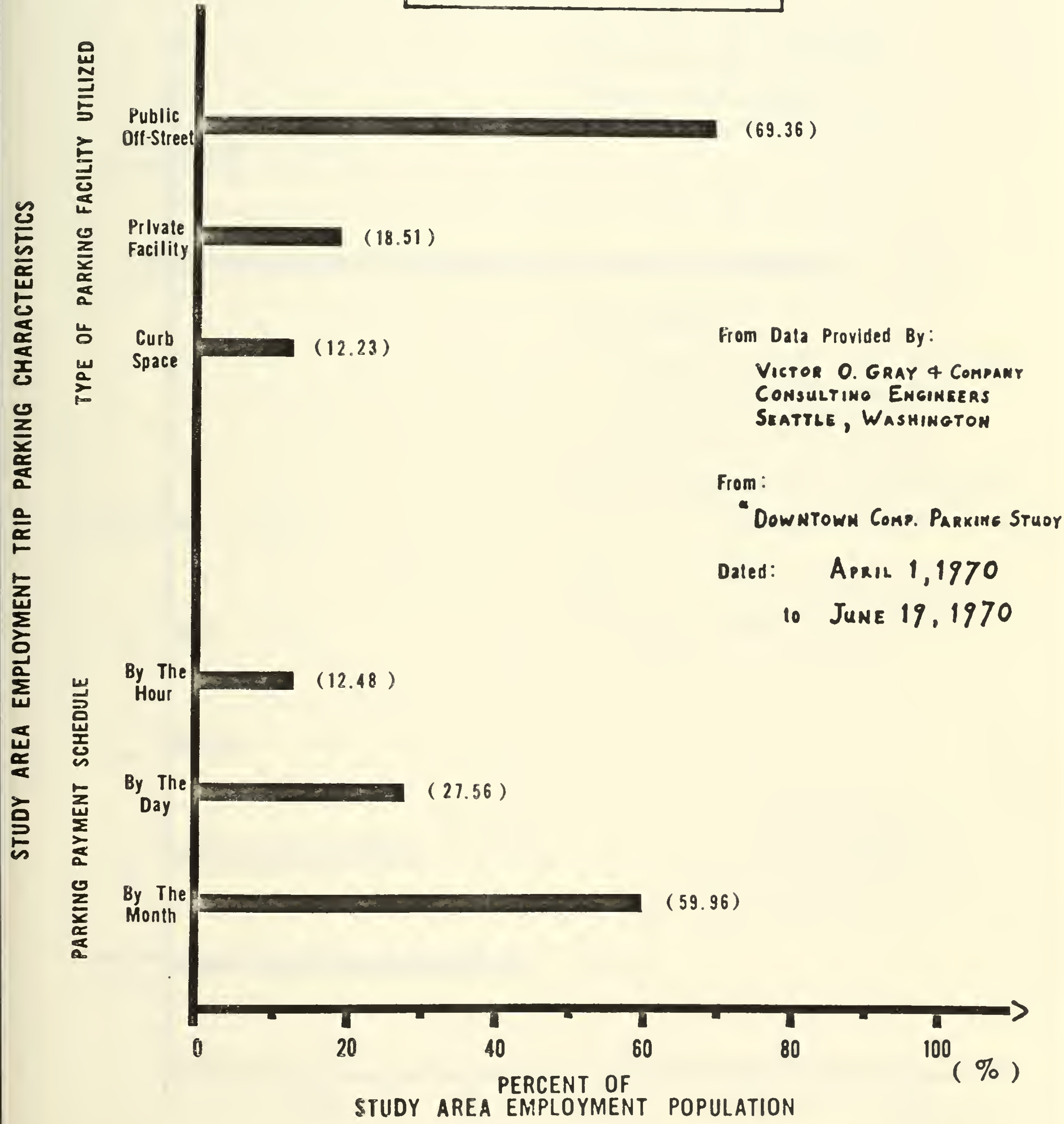
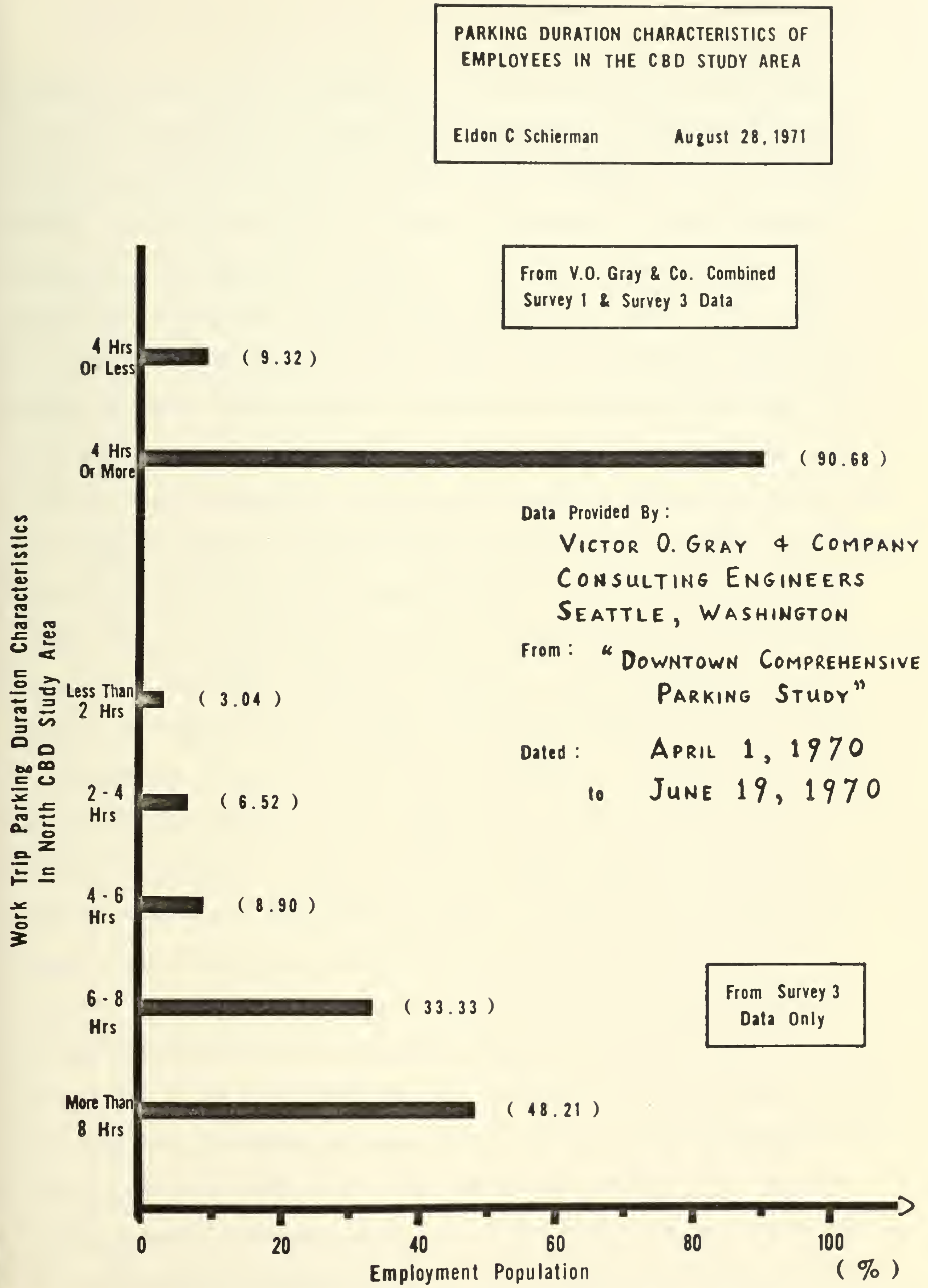


FIGURE 7



PARKING DURATION CHARACTERISTICS OF EMPLOYEES IN THE CBD STUDY AREA
Eldon C Schierman
August 28, 1971
From V.O. Gray & Co. Combined Survey 1 & Survey 3 Data
4 Hrs Or Less
(9.32)
4 Hrs Or More
(90.68)
Data Provided By :
VICTOR O. GRAY & COMPANY
CONSULTING ENGINEERS
SEATTLE, WASHINGTON
From : "DOWNTOWN COMPREHENSIVE PARKING STUDY"
Dated : APRIL 1, 1970
to JUNE 19, 1970
Work Trip Parking Duration Characteristics In North CBD Study Area
Less Than 2 Hrs
(3.04)
2 - 4 Hrs
(6.52)
4 - 6 Hrs
(8.90)
6 - 8 Hrs
(33.33)
From Survey 3 Data Only
More Than 8 Hrs
(48.21)
0
20
40
60
80
100
Employment Population
(%)

FIGURE 8

satisfy the three basic assumptions previously discussed in this report. In their investigation the consultants computed an estimate of the total long term parking demand and long term supply available for each individual block. The supply available, of course, is based on a careful inventory of spaces. The demand is a function of floor space area (sq. ft.) and an empirically determined long-term parking generating factor. This factor is a function of floor space usage, square foot area, number of employees, number of survey forms returned, and number of parkers with duration over four hours. A detailed tabulation of parking supply and demand data by block is found in Appendix B, along with an example derivation illustrating how Victor O. Gray and Company arrived at their various assigned generating factors. From the data and calculations found in the appendix, it is concluded that the study area in question has an available long-term parking supply of 6,141 spaces, whereas the estimated long-term demand is 7,713 spaces. In other words, the demand exceeds the supply by some 1572 spaces. With reference to the data presented in Appendix A, a tabulation by origin postal zip code lcoation is made, listing the number of questionnaires returned in Survey's # 1 and # 3. The zip codes listed are only those that satisfy assumption C discussed previously, in that they are located somewhere to the north of the northern downtown area (see Figures 9 and 10). From the data shown, it can be seen that 1495 of the people responding to the surveys came from one of the areas listed. These 1495 responses represent 62.55% of the total 2390 responses received by the consultants in their investigation. Therefore, of those people who work in the designated study area and who drive their car to work and park it downtown (the long-term parking demand), it is assumed that 62.55% represents the best estimate of the percentage who came from the north. Multiplying the long-term demand

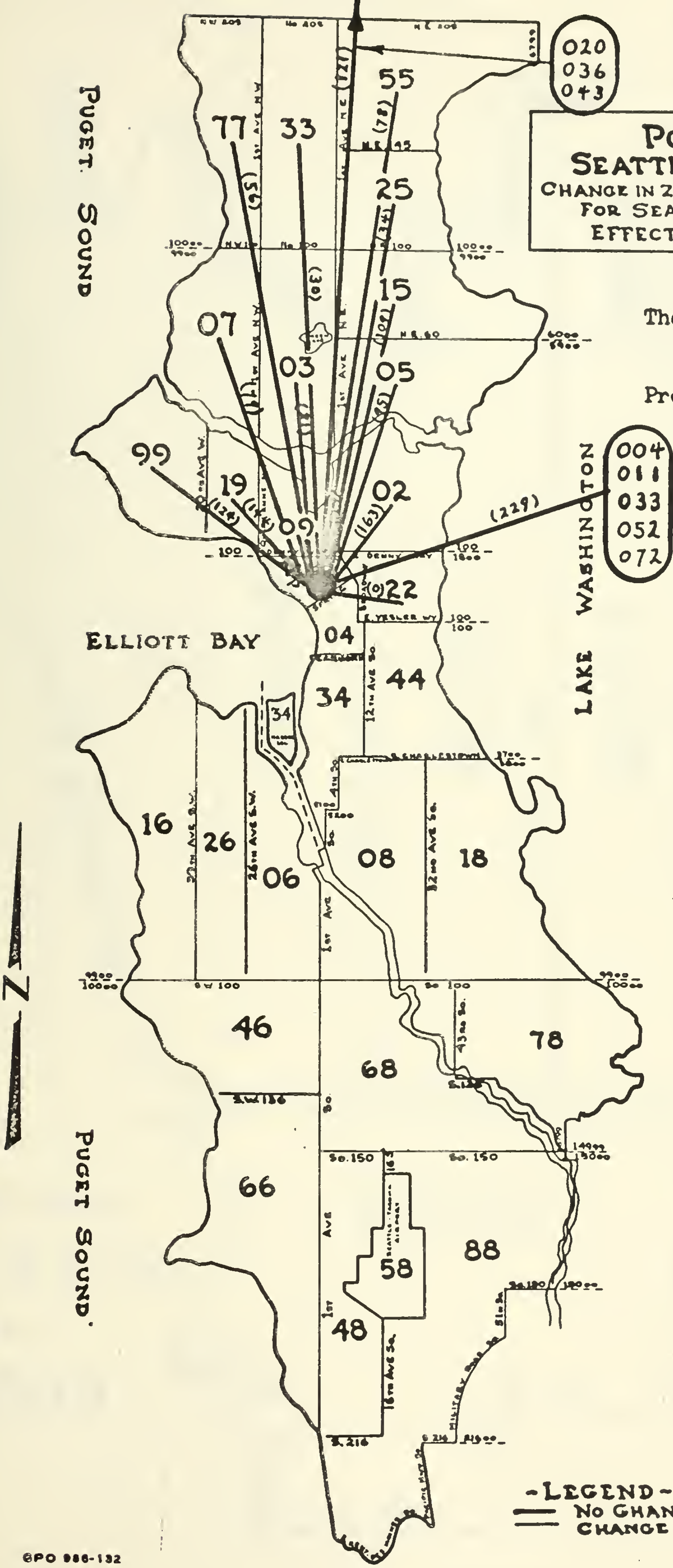
of 7713 by 0.6255, it is concluded that approximately 4824 employees work in the downtown who satisfy all three of the basic assumptions for this study that were listed earlier.

DETERMINATION OF PUBLIC ACCEPTANCE

After establishing a total study employment population of approximately 4900 workers (rounded from 4824), the next order of business is the determination of their reaction to, and acceptance of, the proposal to extend the Monorail. Since no previous data existed which dealt specifically with the proposal at hand, it was decided that a survey of some sort was necessary to establish the number of workers who might be attracted to the Seattle Center to park. A questionnaire was authored, stapled to a pre-addressed return envelope, and prepared for distribution in the downtown area. A detailed discussion of the survey and how it was conducted is found in Appendix C. After an initial test of the original questionnaire at one parking garage location, some of the questions were modified, and the questionnaire in its final form was then distributed in mass. A total of 1738 forms were distributed (including those of the initial test survey), with 632, or 36.4% of that total being returned. Of those 632 questionnaires, a total of 286, or 45.3%, were identified as satisfying the three basic assumptions associated with this investigation. These formed the sample used in the final analysis. Of the remaining questionnaires, 72 were unidentifiable because of incomplete responses, or in the case of those having Bellevue zip codes, inconclusive evidence existed as to the route used across Lake Washington. Adjusting the return accordingly, it is found that the final usable sample of 286 represents 51.1% of the final usable return of 560 forms.

POST OFFICE
SEATTLE, WASHINGTON 98101

CHANGE IN ZONE NUMBERS & BOUNDARIES
FOR SEATTLE, WASHINGTON
EFFECTIVE JULY 1, 1963



The ZIP Code for Seattle is:

981

Precede ALL Zones with '981'

Example:

John Doe
1220 3rd Ave.
Seattle, Washington 98101

or

John Doe
1220 3rd Ave.
Seattle, Washington
98101

FIGURE 9

GPO 986-132

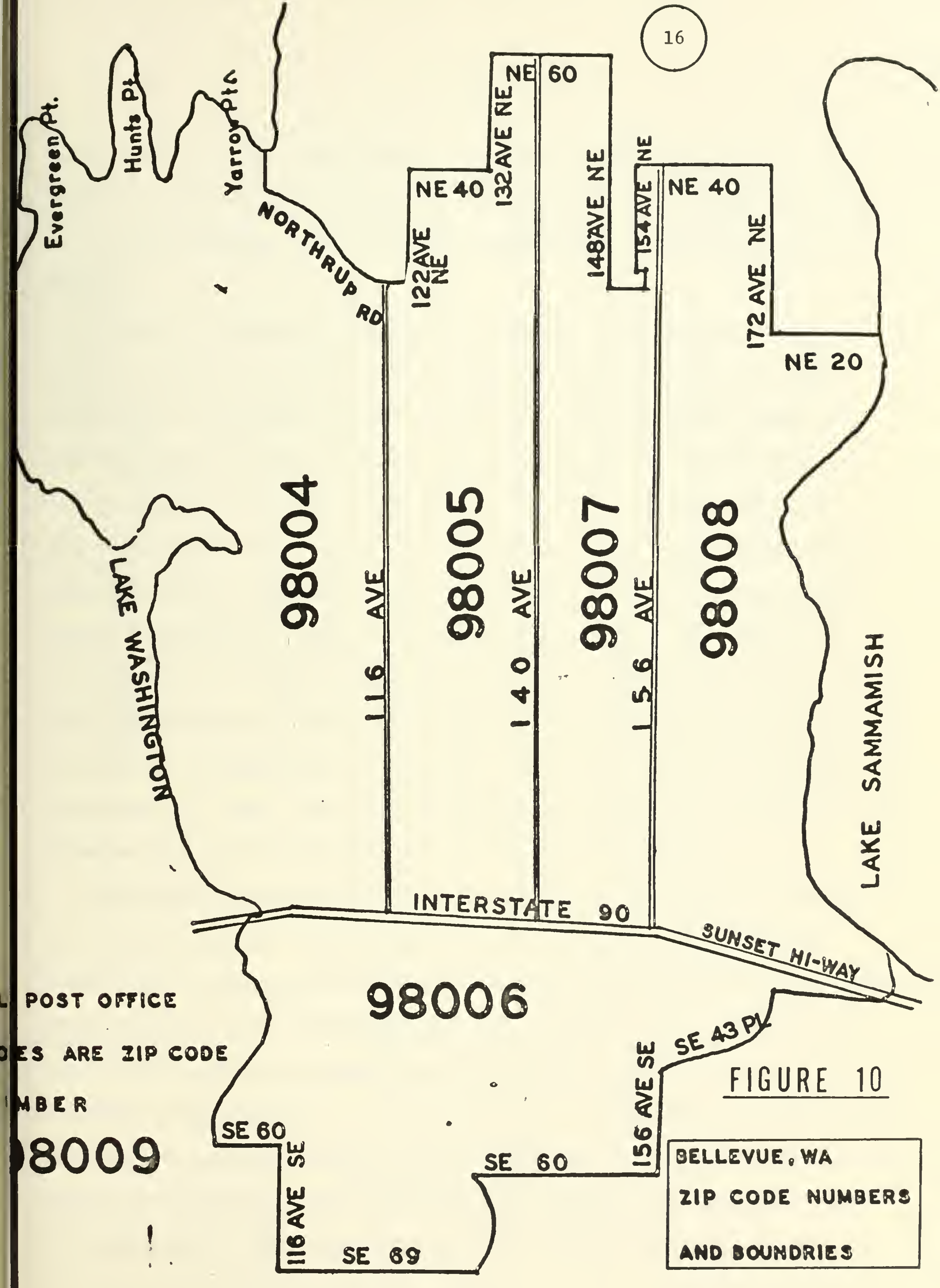


FIGURE 10

BELLEVUE, WA
ZIP CODE NUMBERS
AND BOUNDRIES

From the 286 response sample (which represents a 16.5% return of the total survey distribution), the responses to the questions were tabulated by means of a computer program. The resulting printed output is included as a part of Appendix C.

Figures 11 through 15 illustrate the results of the survey. As can be seen from Figure 11, 31.07% of those responding indicated that they liked the proposal and would be willing to park at the Seattle Center Garage and ride the Monorail to work downtown. Of those individuals responding with a "no" to the proposal, nearly half (44.56% - see Figure 12) indicated that they required the use of their car from time to time during the work day and that parking at the Seattle Center would not provide them with the necessary vehicle availability. Another 12.93% of those responding felt that it was more convenient to drive directly downtown than to negotiate the trip to the Seattle Center Area. This type of response came primarily from those people who come from neighborhoods near downtown, i.e., the Capital Hill and Model City areas, and, also, from those individuals who object to the present access situation between Seattle Center and the Interstate-5 freeway.

The Seattle Transit System presently operates a "park-and-ride" parking lot directly adjacent to the Seattle Center. This lot is located on 5th Avenue North across from the High School Memorial Stadium and south of Transit's Mercer Street storage and maintenance shops. For 50¢ a day, a commuter may park his car and, also, receive a round-trip ride on any one of the bus routes traveling along 5th Avenue to the downtown area. The operation of the lot has met with only marginal success, with approximately 1/3 of the 550 spaces being filled each week-day. Since the function of Transit's "park-and-ride" system is very similar to what is proposed for the Monorail and Parking Garage, it

Estimated Percent Of Selected Employment Population Indicating Willingness To Park At The Seattle Center And Ride The Monorail To Work Downtown.

Eldon C Schierman July 8,1971

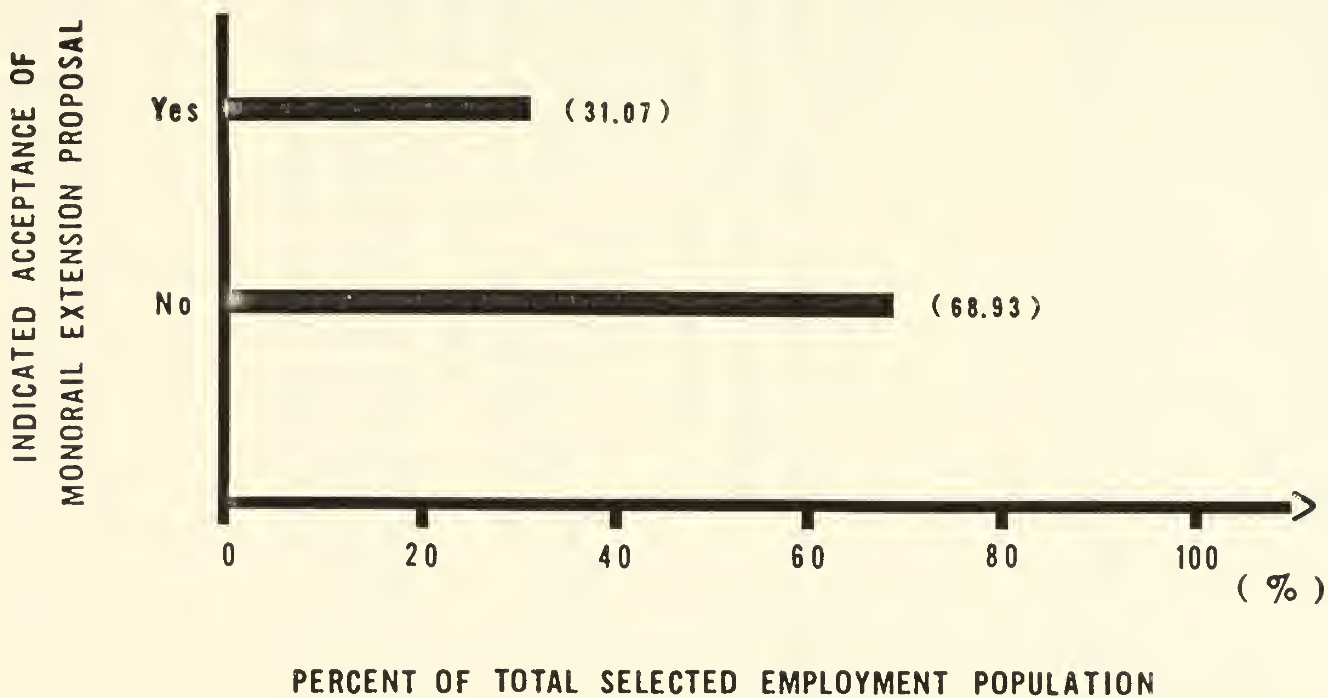


FIGURE 11

REASONS GIVEN FOR NOT BEING WILLING TO PARK AT THE SEATTLE CENTER AND RIDE THE MONORAIL TO WORK DOWNTOWN.

Eldon C Schierman July 8, 1971

Number Of Unfavorable Responses In Survey To Monorail Extention Proposal – 193

UMBER OF YPE RESPONSE	PERCENT OF TOTAL	
18	9.33%	No Comment
13	6.74	Present Garage More Conviently Located Than Downtown Terminal
12	6.23	Employer Provides Car And/Or Parking
25	12.93	More Convient To Drive Downtown
86	44.56	Use Car During Working Day
5	2.59	Other Existing Forms Of Transit More Convenient
5	2.59	Require Night-time And Weekend Parking
4	2.07	Normally Don't Drive To Work
16	8.29	Present Parking And Driving Time And Costs Are Less Than Those Anticipated For Seattle Center Parking
9	4.67	Poor Access Between Seattle Center And I-5
193	100.00%	Total

FIGURE 12

was felt necessary to investigate a potential relationship between awareness and past usage of Seattle Transit's lot and the acceptance or rejection of the proposed Monorail "park-and-ride" system. Figure 13 illustrates a percentage breakdown of the results. Of those responding "yes" to the Monorail proposal, slightly more than 50% indicated that they were aware of Seattle Transit's "park-and-ride" system. Of those rejecting the Monorail proposal, 57.51% listed that they were aware of Transit's lot. It is concluded, therefore, that awareness of Seattle Transit Company's "park-and-ride" parking system was not a significant factor in the type of answer that was offered in response to the basic proposal question. Figure 14 illustrates a measure of the degree of usage of the "park-and-ride" lot. It is interesting to note that only about 10% of those people who are aware of the lot's existence actually have used the system. At first glance this figure might indicate the existence of a rather large rejection factor of "parking-and-ride" parking systems by Seattle commuters. However, some objectionable conditions inherently exist in Seattle Transit's system which would not exist in a Monorail system and which hopefully would spell the difference between failure and success. Further discussion of this subject is found in later chapters.

Finally, it is concluded that given the right price, approximately 31.1% of 4900, or 1525 drivers, could be attracted to the Seattle Center Parking Garage. Determining the price to charge for parking and riding the Monorail is the next problem. From the questionnaire data, Figure 15 was plotted which illustrates maximum acceptable monthly parking cost as a function of numbers of people (from 0 to 87) who responded "yes" to the proposal. Parallel to the abscissa is a second scale representing the total study population. This scale ranges from 0 to 1525. It is equivalent to the upper

Percent Breakdown (As A Function Of Question 1 Response)
Of Survey Population Who Indicated An Awareness
Of Seattle Transit's "Park-And-Ride" Parking System.

Eldon C Schierman — July 8, 1971

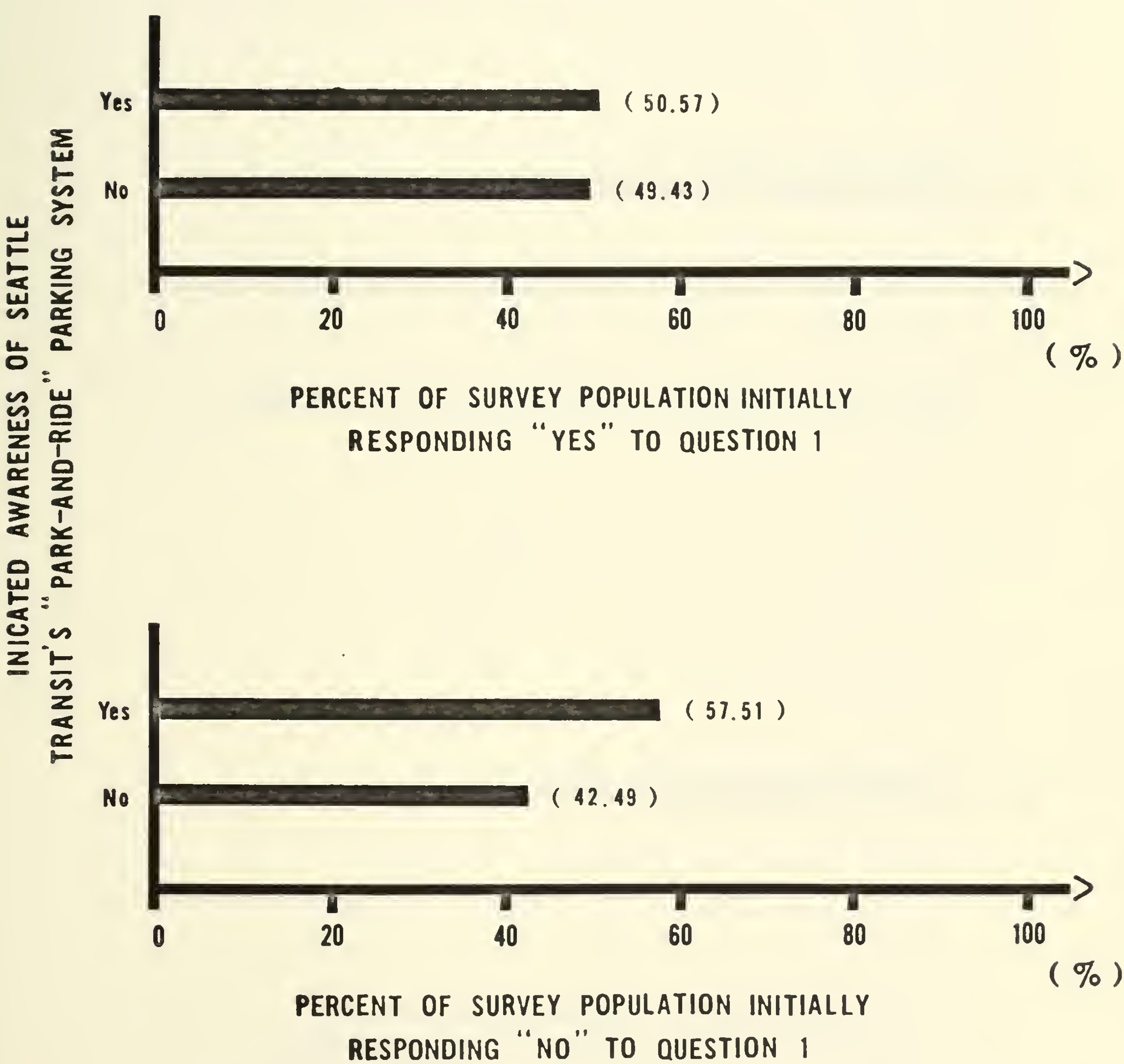


FIGURE 13

Percent Of Survey Population Who Indicated That They Have Previously Used Seattle Transit's "Park-And-Ride" Parking System

Eldon C Schierman July 20, 1971

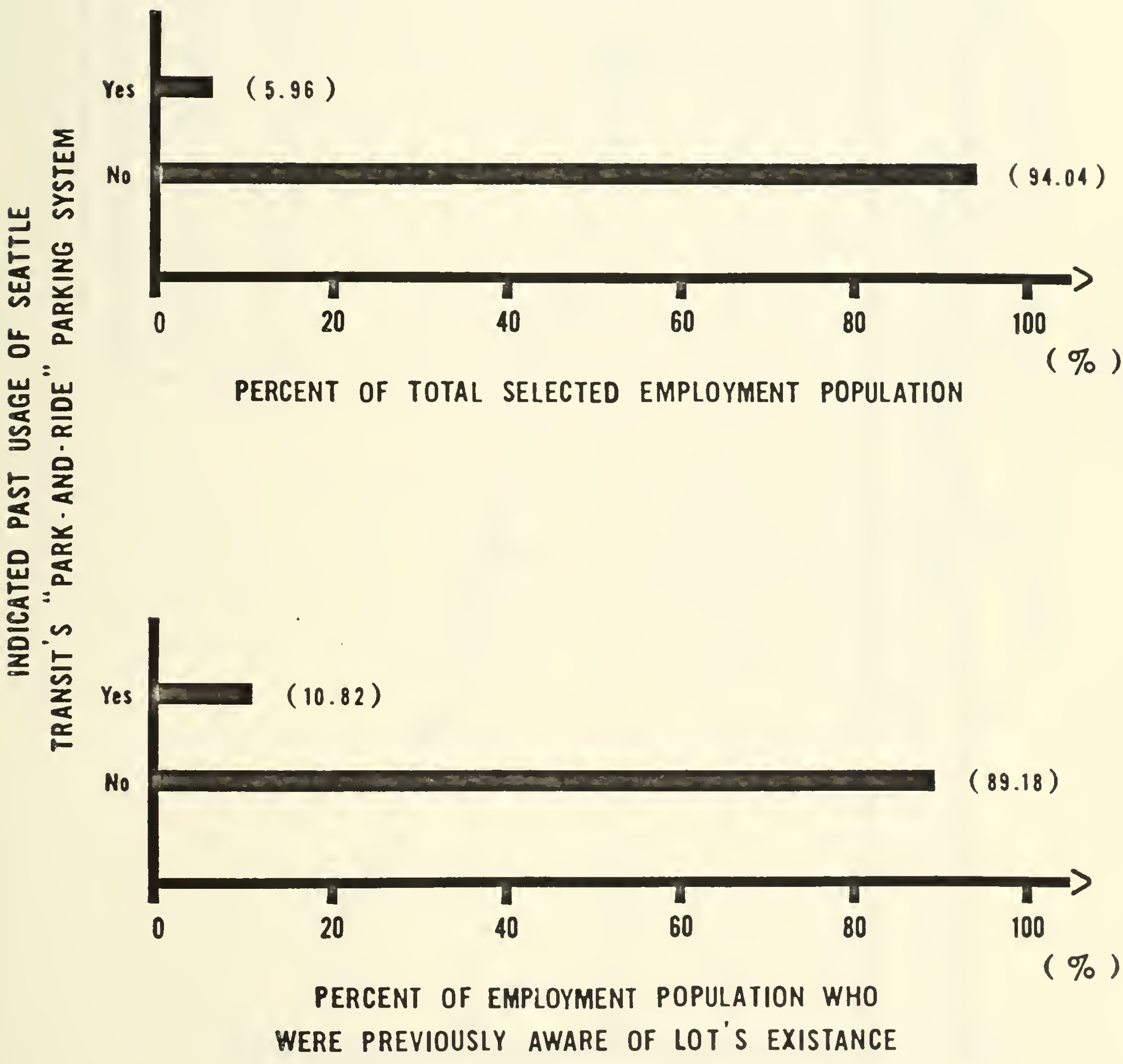


FIGURE 14

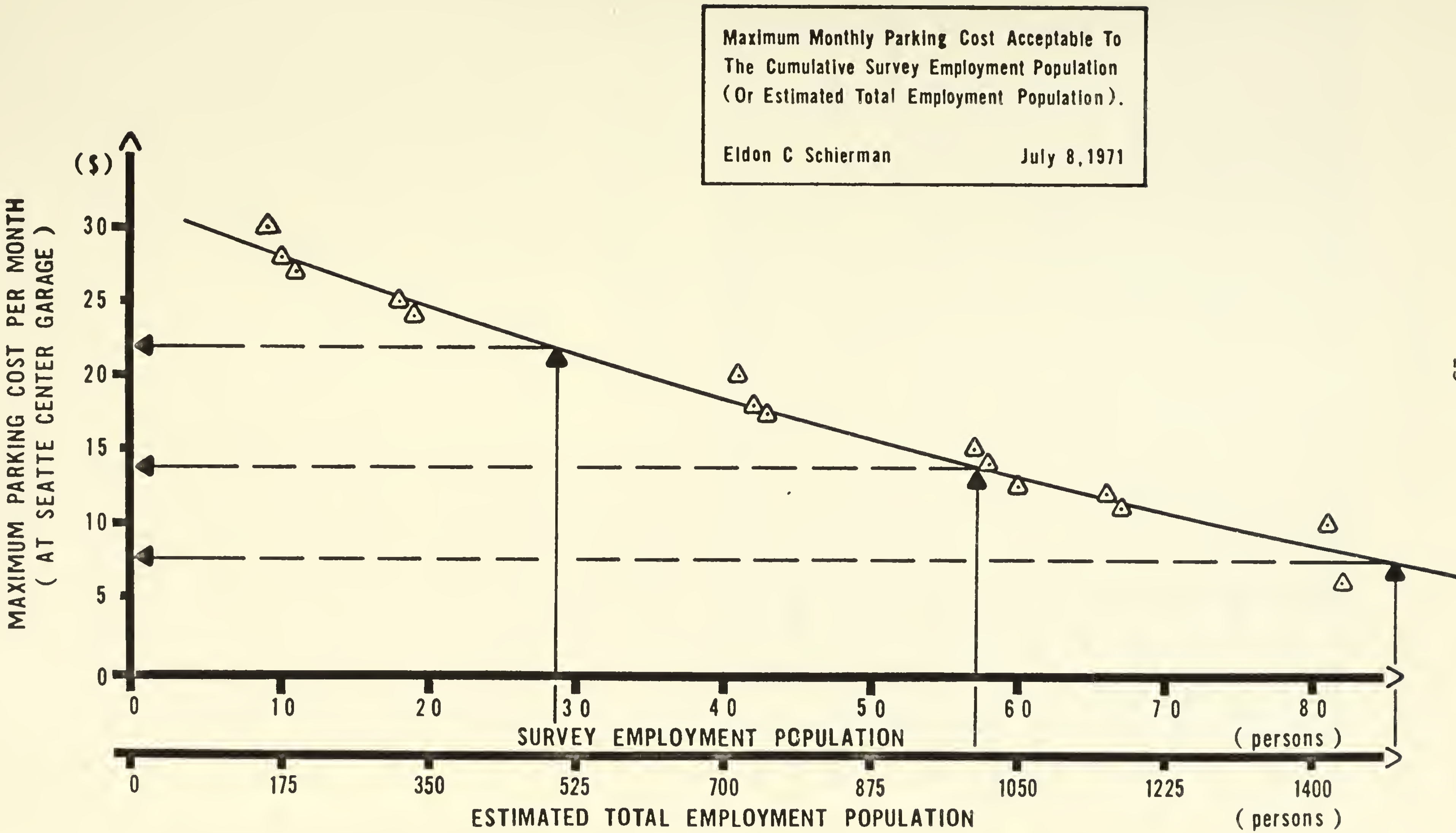

Maximum Monthly Parking Cost Acceptable To The Cumulative Survey Employment Population (Or Estimated Total Employment Population).
Eldon C Schierman
July 8, 1971
($)
MAXIMUM PARKING COST PER MONTH
(AT SEATTE CENTER GARAGE)
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
(persons)
SURVEY EMPLOYMENT POPULATION
0
175
350
525
700
875
1050
1225
1400
(persons)
ESTIMATED TOTAL EMPLOYMENT POPULATION

FIGURE 15

horizontal scale, in that 1525 of the total study employment population represents the same thing as 87 of the survey sample population. Using the bottom, or total study population scale, various maximum monthly costs are determined which should lead to a given number of vehicles being attracted. For example, in order to fill the garage with 1500 vehicles, a monthly rate of $7.50 or less must be charged. If $13.75 per month is charged, then only 1000 vehicles can be expected to park, and if the rate is raised to $22.00 per month, then only 500 cars per day can be expected. In summary, a monthly charge is chosen which can be expected to attract to the system a given number of patrons, resulting in the most favorable benefit-cost ratio. The exact monthly rate, and subsequent anticipated patronage, is found in Chapter IV, which deals with determination of the benefits, costs, and optimum benefit-cost ratio of the system.

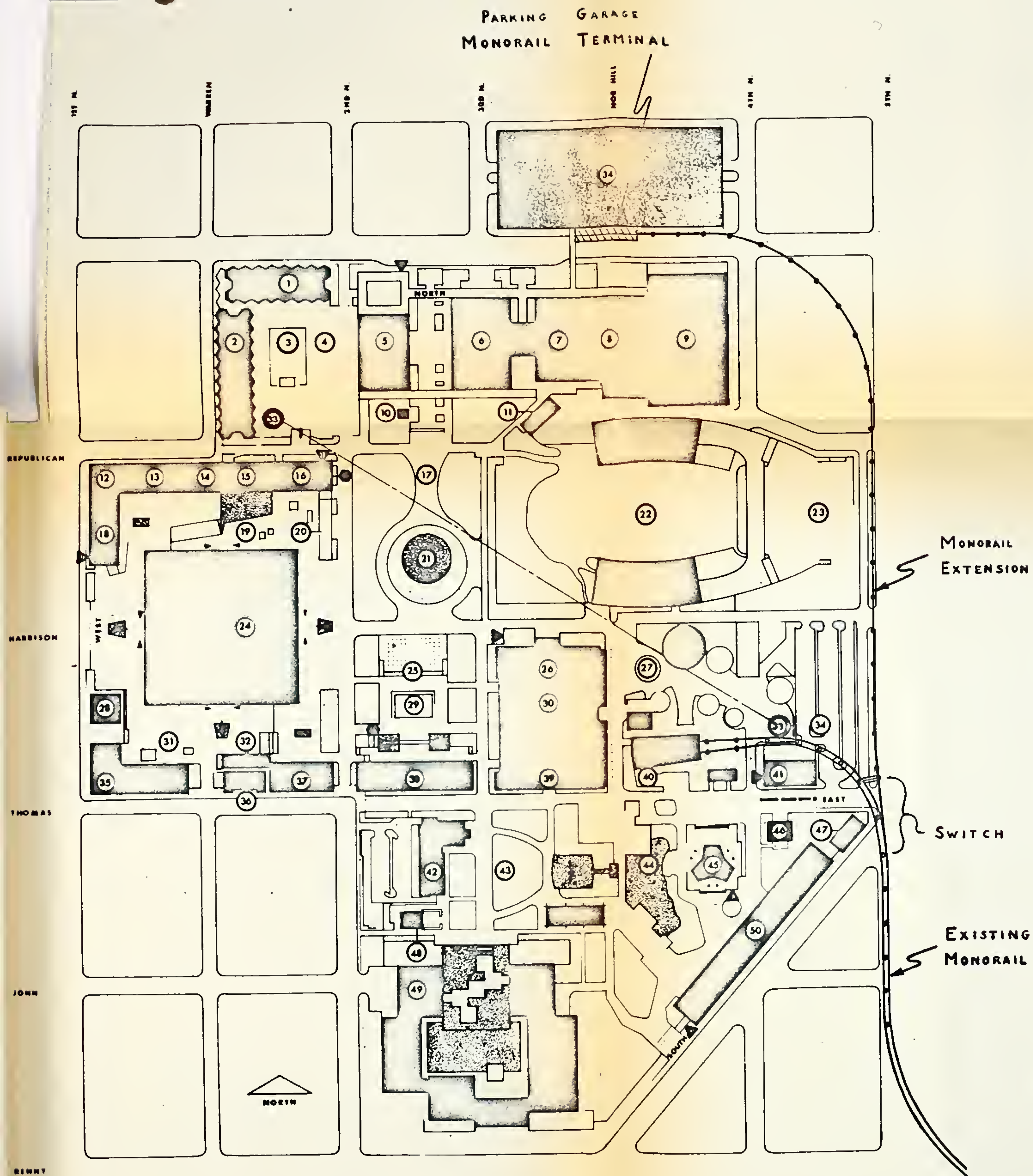
CHAPTER III

ESTIMATED ALTERATIONS TO COMMUTER TRAFFIC IN THE VICINITY OF THE SEATTLE CENTER AS A RESULT OF MONORAIL EXTENSION

In this chapter is is assumed that the hypothetical extension of one rail of the Monorail north along 5th Avenue North to connect directly to the Seattle Center Garage (see Figure 16) has actually taken place. The following paragraphs examine the existing arterial street system in the vicinity of the Seattle Center, along with a capacity analysis of select, critical intersections. Also discussed are the most probable access routes to the Seattle Center from the north, assignment of additional vehicles to these routes as a result of Seattle Center Garage attraction, and a review of the anticipated operation of the access corridors as a result of the additional traffic. Of final interest are the physical alterations to the street system around the Seattle Center which are recommended as the result of the Monorail extension, or which can be anticipated to take place based on separate, independent planning by the City of Seattle.

THE EXISTING ARTERIAL STREET SYSTEM IN THE VICINITY OF THE SEATTLE CENTER - A CAPACITY ANALYSIS OF SELECT ACCESS ROUTES

Figures 17 and 18 illustrate the lay-out of the city streets in the vicinity of the Seattle Center between Puget Sound to the west and the Interstate-5 corridor to the east. The direction of traffic movement along the major arterial streets are shown in these figures. Figures 19 and 20 show the same area as before with the major commuter access routes color-coded in as shown. The arrows in Figures 19 and 20 indicate a predominately one-way access traffic flow, even though the street itself may operate as a



SEATTLE CENTER DIRECTORY

1. Storage Building
2. Storage Building
3. Bandstand
4. Northwest Square
5. Playhouse
6. Exhibition Hall
7. Opera House
8. Display Hall
9. Arena
10. Kobe Bell
11. Veteran's Building
12. Olympic Room
13. San Juan Rooms
14. Nisqually Room
15. Snoqualmie Room
16. Alki Room
17. International Fountain Mall
18. Rainier Room
19. Coliseum North Court
20. Northwest Craft Center
21. International Fountain
22. High School Memorial Stadium
23. Memorial Plaza
24. Coliseum
25. Plaza of the States
26. Administration Offices
    Meeting & Rehearsal Rooms
    Attic Theater (Park Dept.)
27. Fun Forest
28. State of Washington Building
29. Plaza Restaurant
30. International Bazaar
31. Coliseum South Court
32. Maintenance Shops
33. Sky Ride
34. Parking
35. Storage Building
36. 158 Thomas Building
37. Seattle Art Museum Pavilion
38. Flag Plaza Pavilion
39. Food Circus & Show Balcony
    Pottery Northwest Workshop
40. Monorail
    Summer Information Booth
41. Fire Alarm Center
42. Nile Temple
43. Mural Amphitheater
44. Lagoon
45. Space Needle
46. Piccoli Theater
47. Cascade Gallery
48. Covered Rest Area
49. Pacific Science Center
50. Hall of Aviation (S. Section)
    Hall of Fire Engineers (Mid-Section)
    Storage (N. Section)

SEATTLE CENTER

SEATTLE WASHINGTON

PAUL THIRY ARCHITECT FAIA

CS 28.43

FIGURE 16

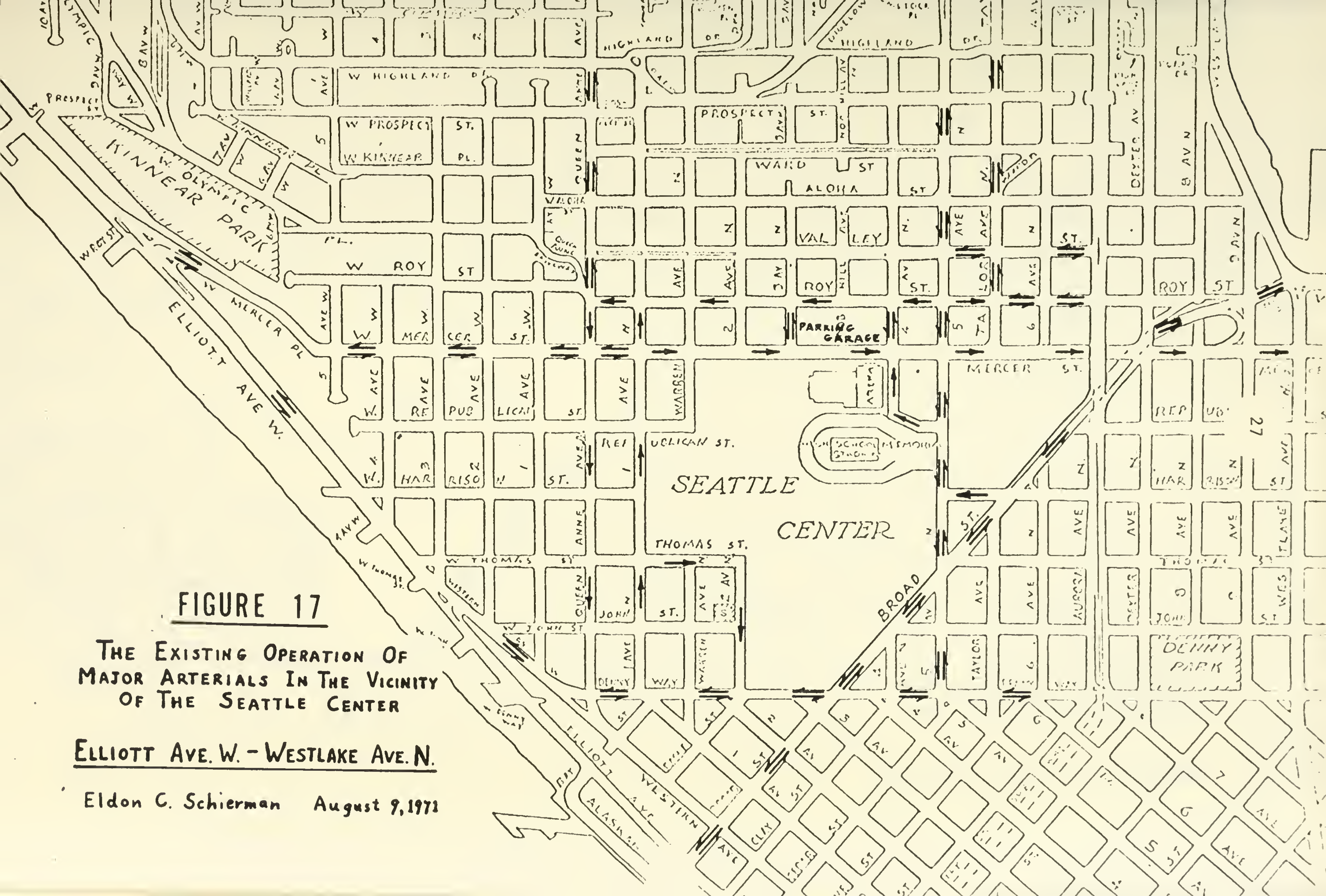


FIGURE 17

The Existing Operation Of Major Arterials In The Vicinity Of The Seattle Center

Elliott Ave. W. - Westlake Ave. N.

Eldon C. Schierman August 9, 1971

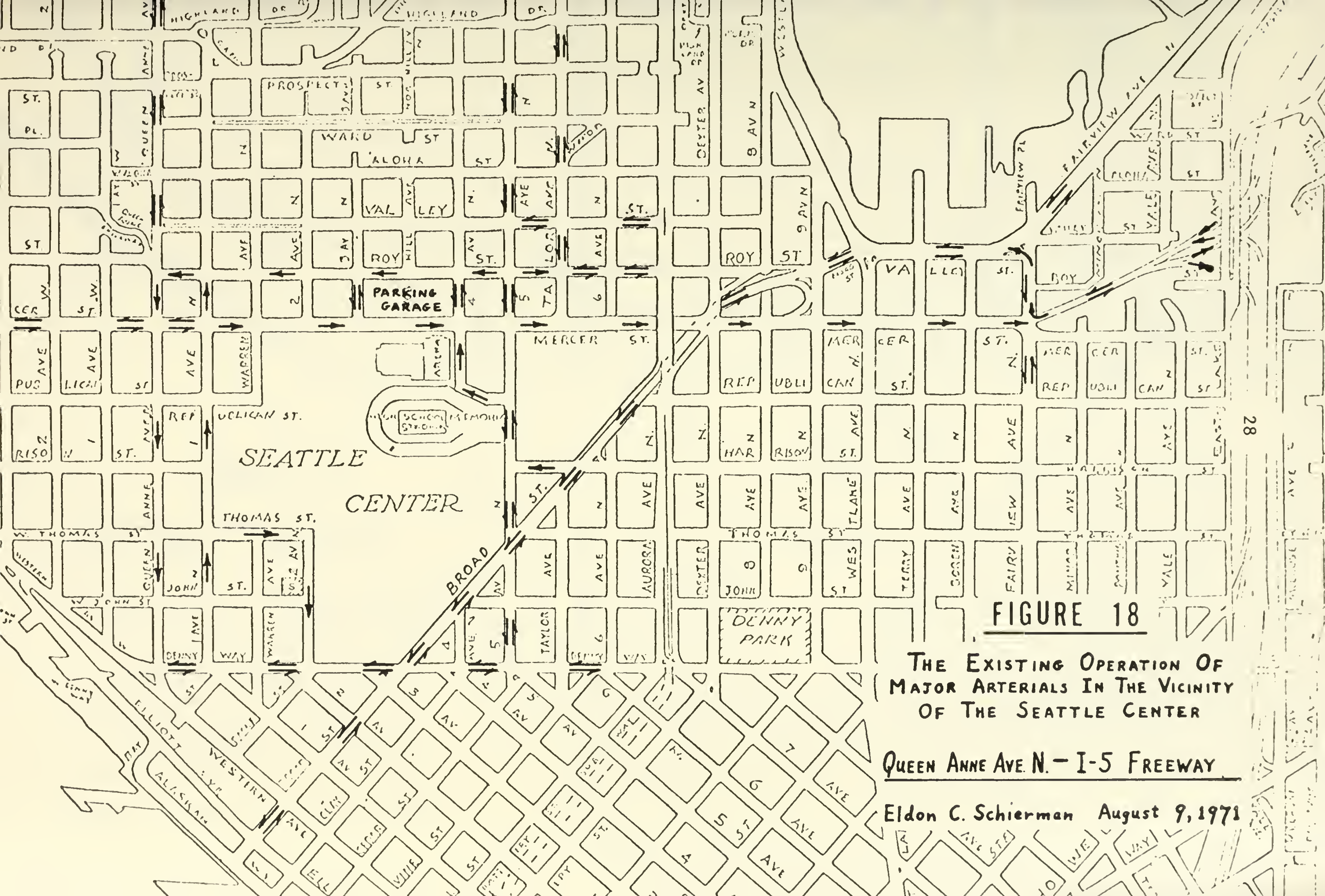


FIGURE 18

THE EXISTING OPERATION OF MAJOR ARTERIALS IN THE VICINITY OF THE SEATTLE CENTER

QUEEN ANNE AVE. N. – I-5 FREEWAY

Eldon C. Schierman August 9, 1971

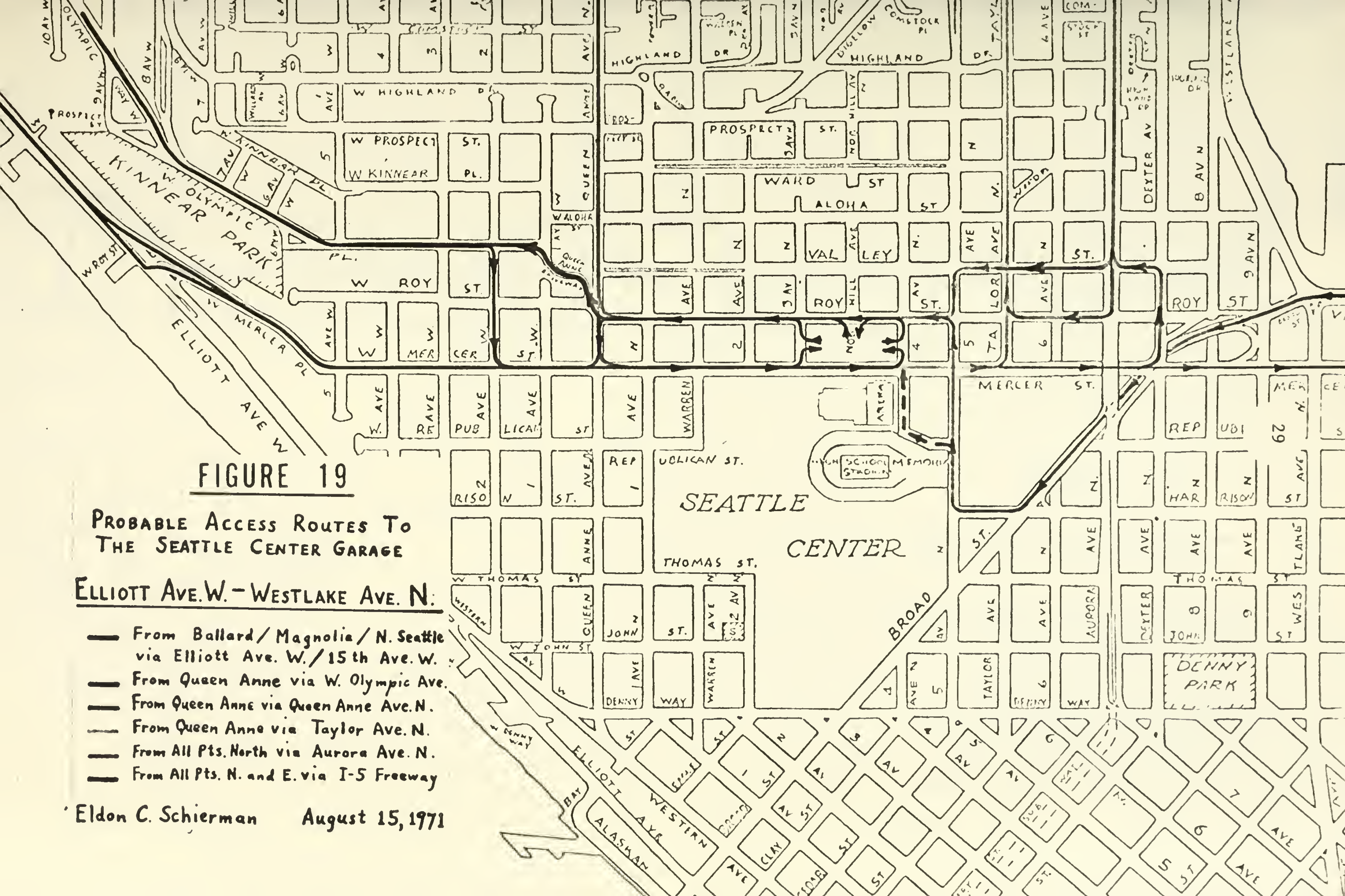


FIGURE 19

PROBABLE ACCESS ROUTES TO
THE SEATTLE CENTER GARAGE

ELLIOTT AVE. W. – WESTLAKE AVE. N.

- From Ballard / Magnolia / N. Seattle via Elliott Ave. W. / 15th Ave. W.
- From Queen Anne via W. Olympic Ave.
- From Queen Anne via Queen Anne Ave. N.
- From Queen Anne via Taylor Ave. N.
- From All Pts. North via Aurora Ave. N.
- From All Pts. N. and E. via I-5 Freeway

Eldon C. Schierman August 15, 1971

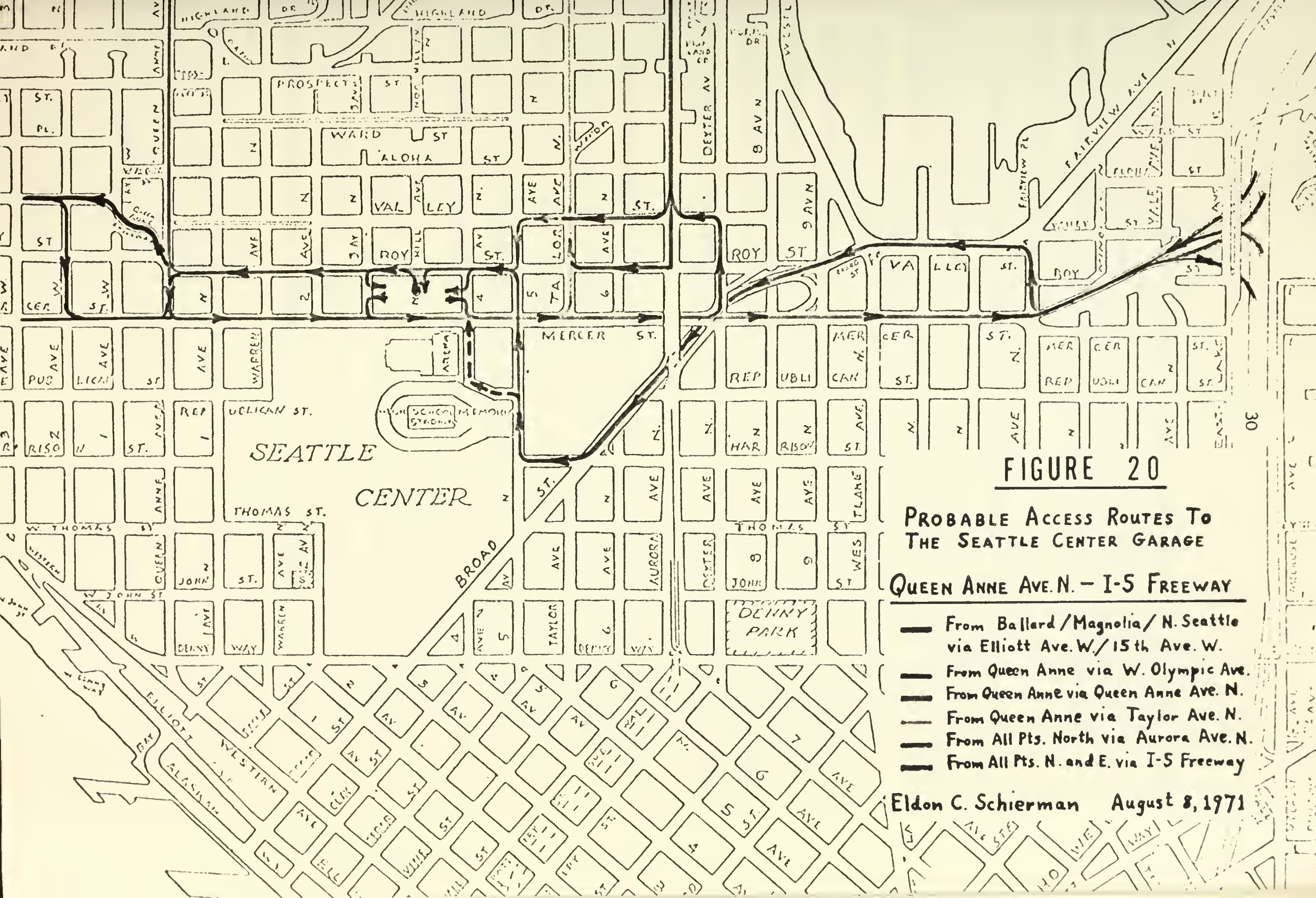


FIGURE 20

PROBABLE ACCESS ROUTES TO THE SEATTLE CENTER GARAGE

two-way street. The routes shown in orange, pink, and blue are minor access routes from the Queen Anne area, while the brown, purple, and green lines indicate major access routes from Elliott Avenue West, Aurora Avenue North, and Interstate-5 Freeway respectively.

With the previously illustrated street system in mind, preparation is made for a capacity analysis of the designated corridors by identifying all of signalized intersections along the routes. Then, existing traffic volumes are assigned to the street system as estimated from manual intersection traffic counts or by automatic counters. Figures 21 and 22 show the estimated traffic volumes for the A.M. peak hour, while Figures 23 and 24 illustrate vehicle volumes for the P.M. peak. The figures also indicate the signalized intersections to be analyzed as small circles at the points where two streets cross.

For the purpose of analysis, the peak hour traffic in the vicinity of the Seattle Center is assumed to be made up of 2.0 per cent trucks and through buses. It is also assumed that the metropolitan population of the Seattle area is 550,000 persons. Peak hour factors for each intersection are estimated by calculating peak hour factors at all points where automatic counts are available. P.H.F.'s are then assigned to the intersections based on the nearest factor actually calculated. The Jack E. Leisch Intersection Capacity Nomographs are employed to determine the vehicle capacity of each designated intersection. Figures 25 and 26 show results of the analysis for the A.M. peak hour (7:30 - 8:30 am). The direction of vehicular movement having the largest V/C ratio is shown for each intersection, along with the respective volume/design capacity ratios (V/C_D - level of service C) and volume / possible capacity ratios (V/C_P - level of service E). The latter

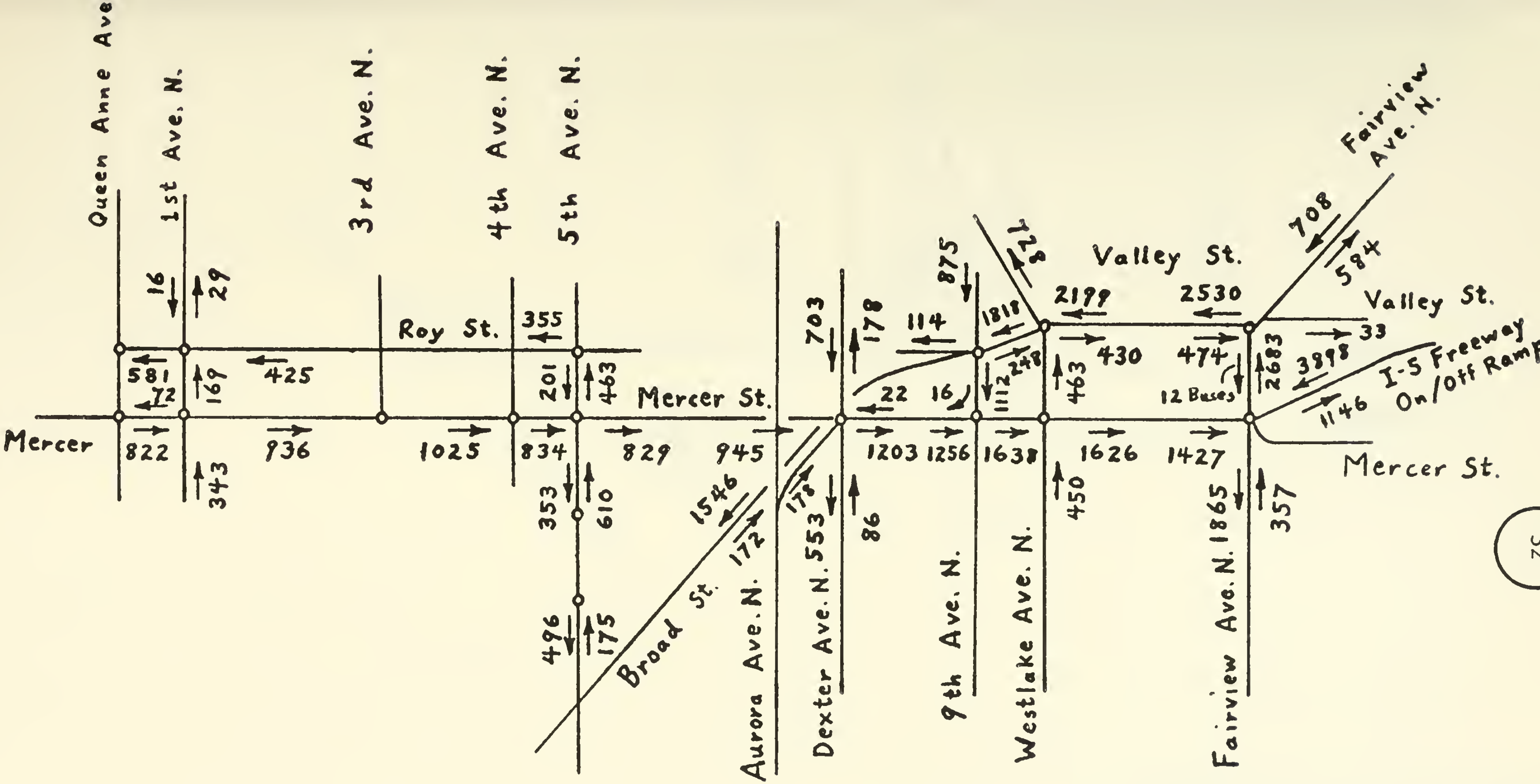


FIGURE 21

A.M. Peak Hour
(7:30 - 8:30 am)
Traffic Volume Counts

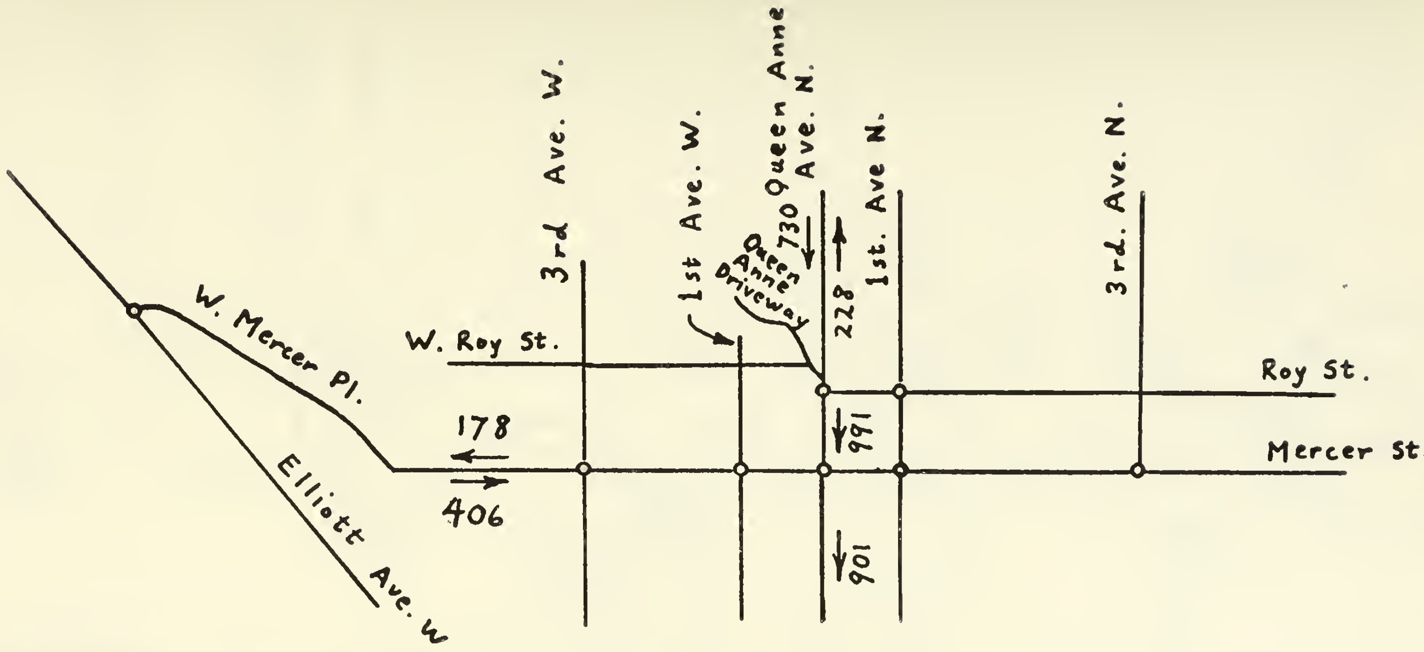


FIGURE 22

A. M. PEAK HOUR
(7:30 - 8:30 am)
TRAFFIC VOLUME COUNTS

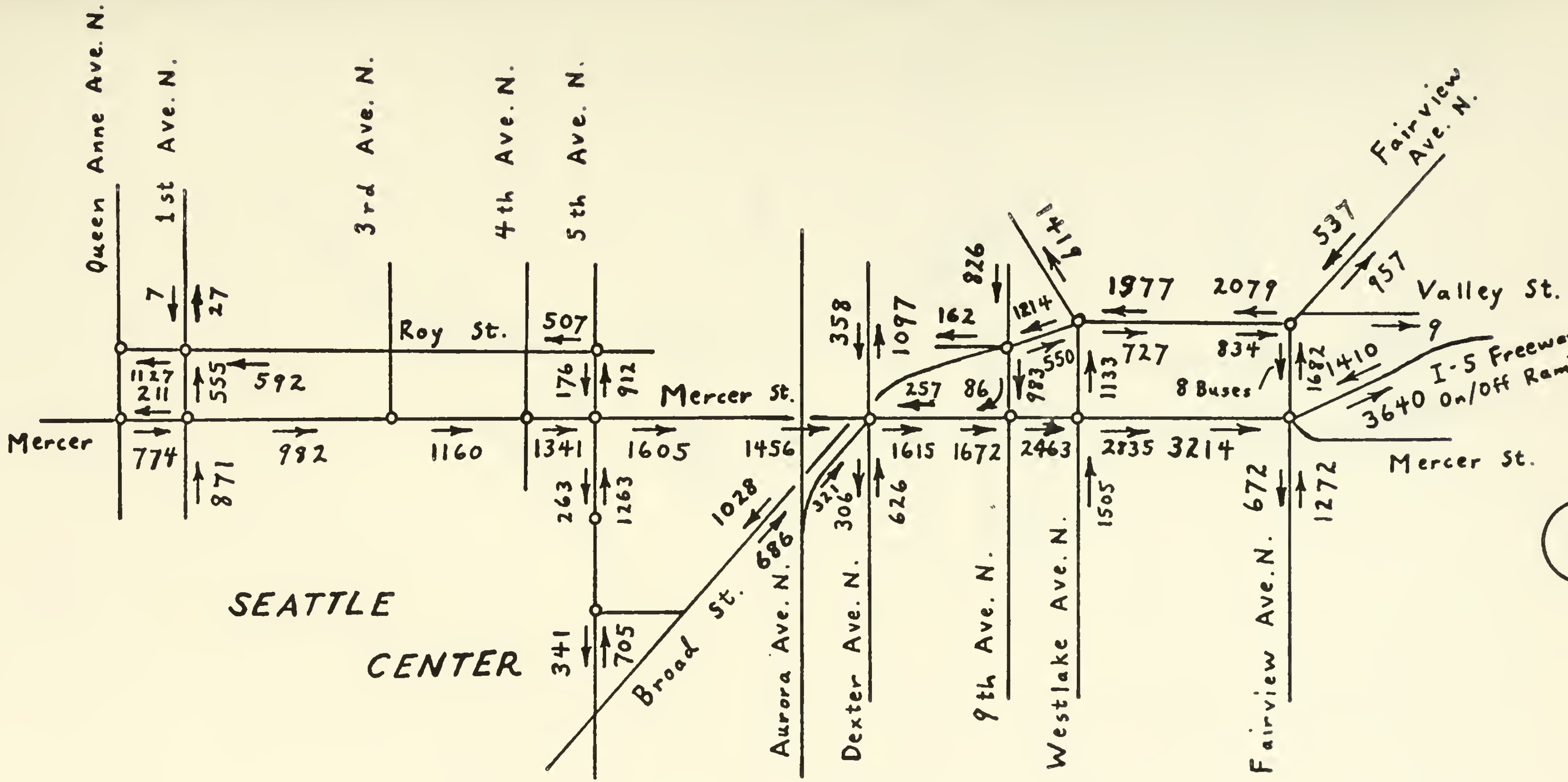


FIGURE 23

P. M. PEAK HOUR
(4:30 - 5:30 pm)
TRAFFIC VOLUME COUNTS

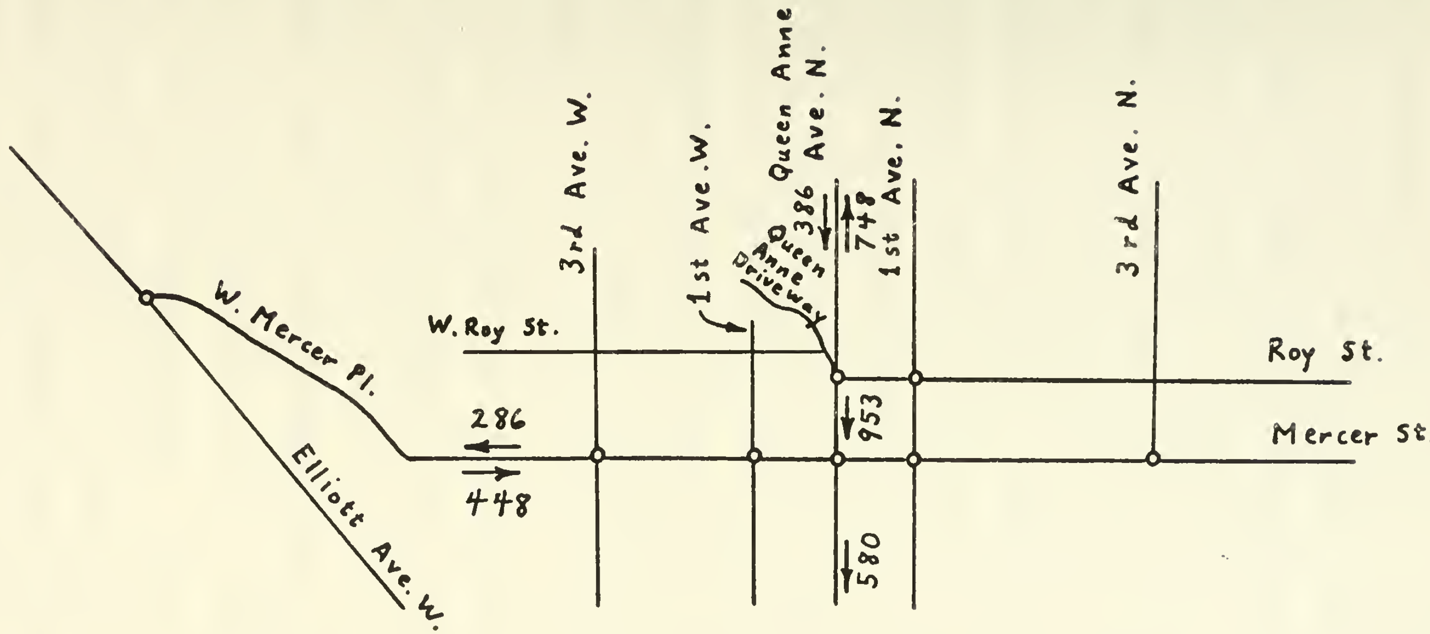


FIGURE 24

P. M. PEAK HOUR
(4:30 - 5:30 pm)
TRAFFIC VOLUME COUNTS

value represents the degree to which a vehicle volume approaches the maximum possible capacity of an intersection. In a manner similar to the A.M. peak hour summary, Figures 27 and 28 illustrate the results of a capacity analysis for the P.M. peak (4:30 - 5:30 pm) volumes. From the four Figures (25 through 28), it can be seen that critical volumes are approached during the A.M. peak at the intersections of Mercer St. and Fairview Avenue N.; Valley Street and Fairview Avenue N.; Roy/Broad Streets and 9th Avenue N.; Mercer Street and 9th Avenue N.; and W. Mercer Place and Elliott Avenue W. During the P.M. peak hour, critical volumes are reached at the intersections of Mercer Street and Fairveiw Avenue N.; Valley Street and Fairview Avenue N.; Mercer Street and Westlake Avenue N.; the Broad Street approach to the intersection of Mercer Street and Dexter Avenue N.; Harrison Street and 5th Avenue N.; Mercer Street and 1st Avenue N.; and W. Mercer Place and Elliott Avenue W.

It is of importance to recall that the main objective of this chapter is to investigate the existing traffic situation along previously mentioned major access routes (see Figures 19 and 20) to and from the Seattle Center Garage. Each of the intersections discussed in the preceding paragraph experiences a critical V/C_P ratio for a particular vehicle movement during either the A.M. or P.M. peak hours. These critical movements, however, do not necessarily coincide with the general flow of traffic towards the Seattle Center in the morning or away from the Seattle Center in the evening. Therefore, they do not necessarily indicate an existing capacity constraint along one or more of the designated routes.

Possibly more revealing of the actual situation are Figures 29 through 32. Figures 29 and 30 illustrate the V/C_D and V/C_P ratios for traffic

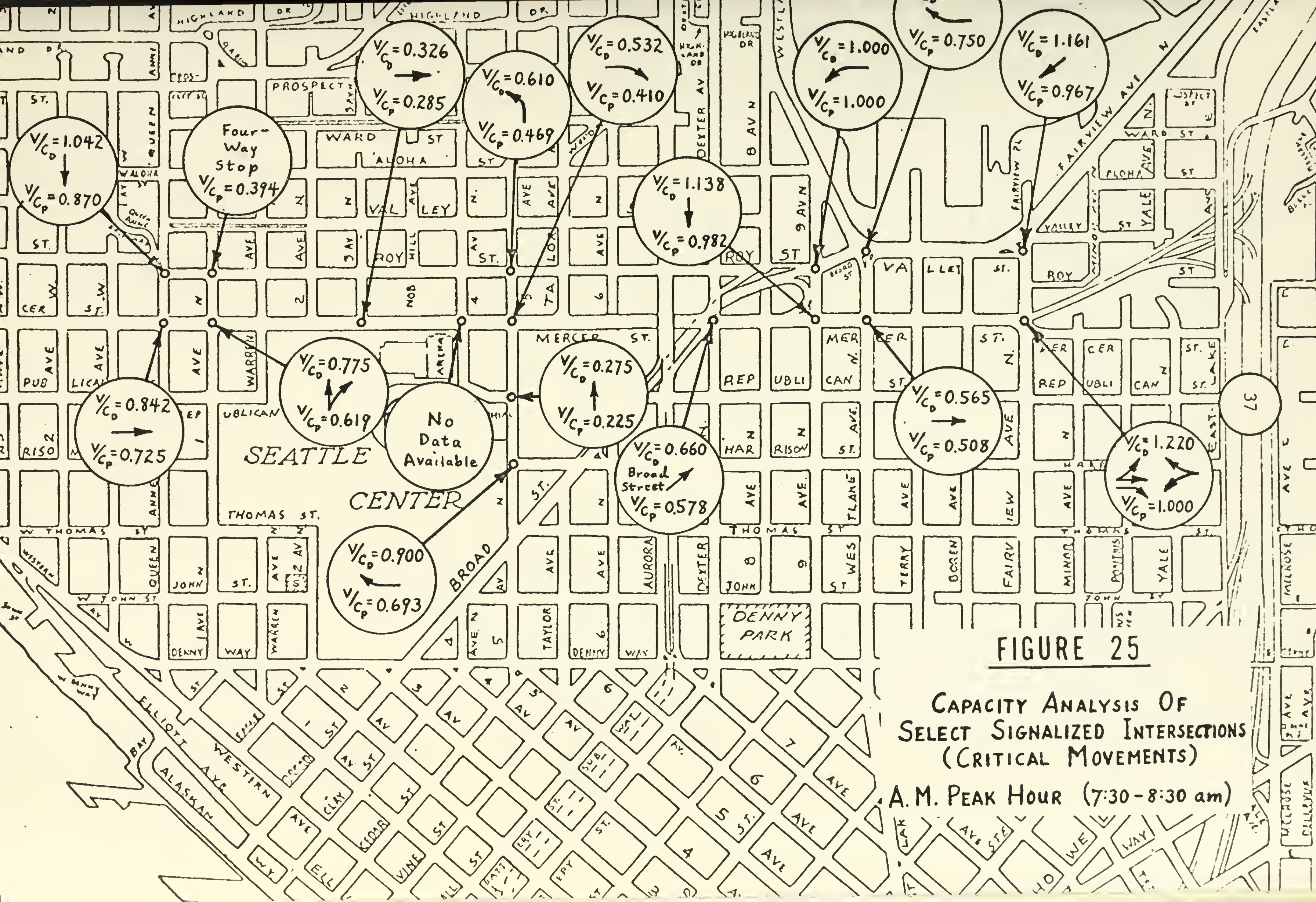


FIGURE 25

CAPACITY ANALYSIS OF SELECT SIGNALIZED INTERSECTIONS (CRITICAL MOVEMENTS)

A.M. PEAK HOUR (7:30-8:30 am)

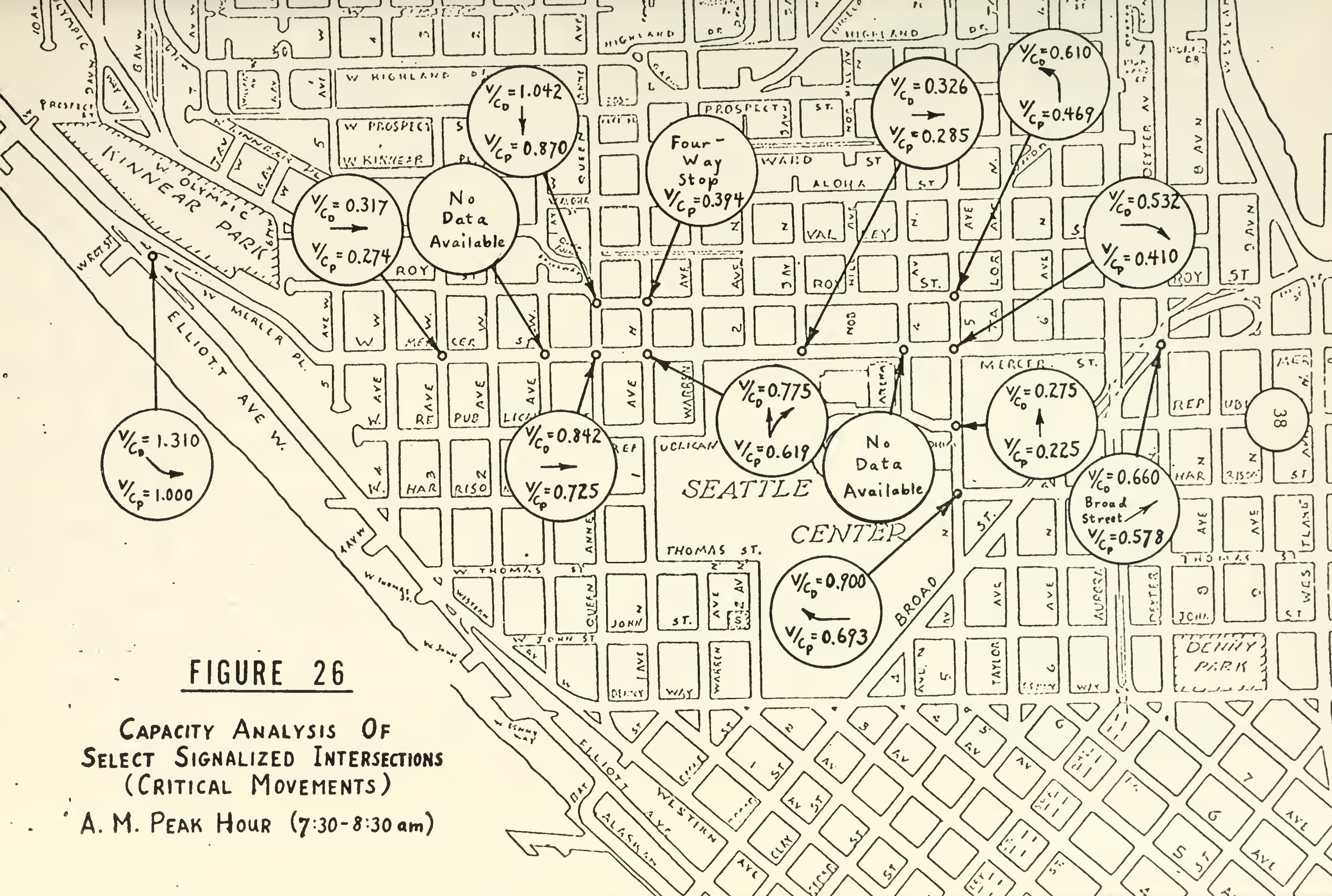


FIGURE 26

CAPACITY ANALYSIS OF SELECT SIGNALIZED INTERSECTIONS (CRITICAL MOVEMENTS)

A. M. PEAK HOUR (7:30-8:30 am)

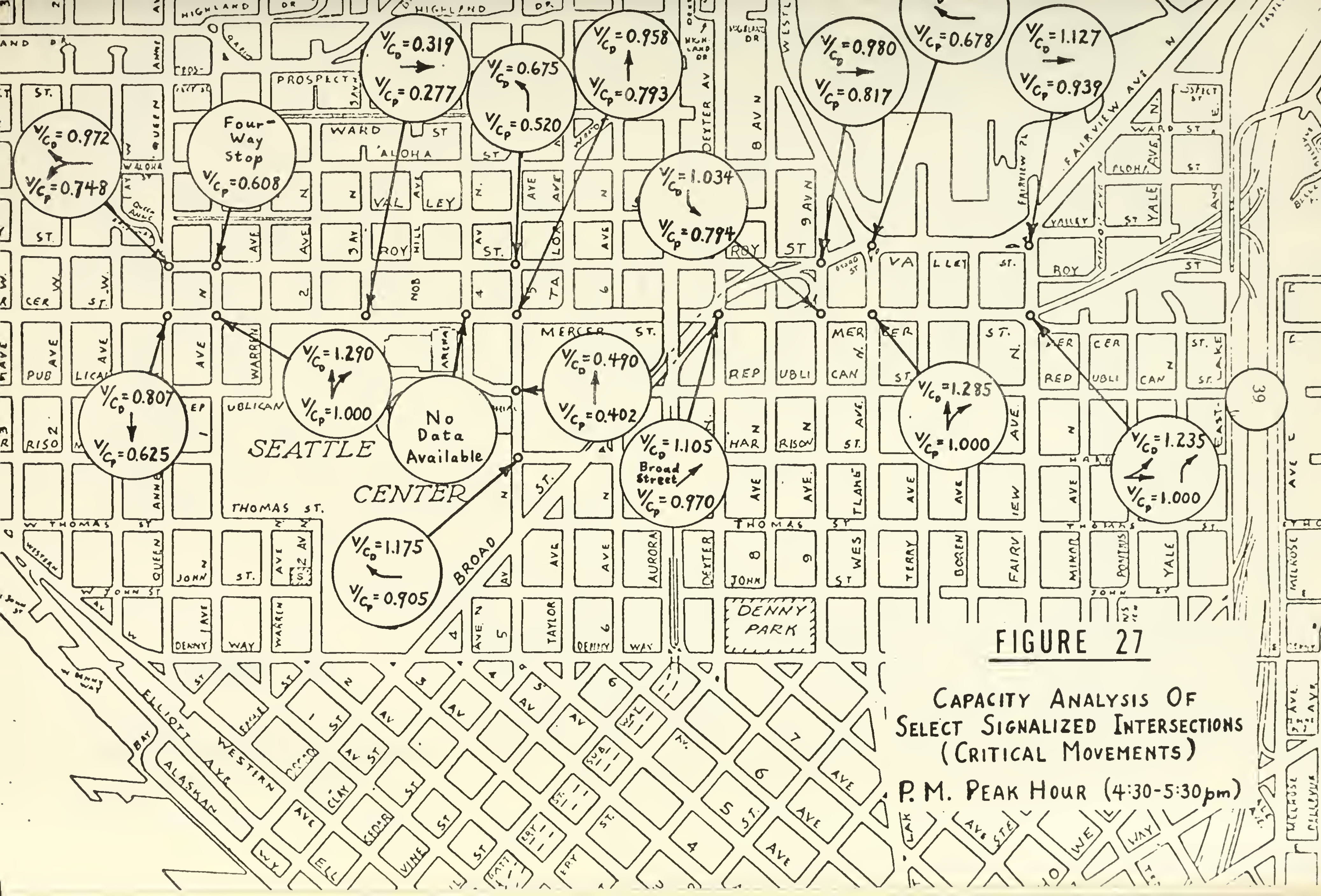


FIGURE 27

CAPACITY ANALYSIS OF SELECT SIGNALIZED INTERSECTIONS (CRITICAL MOVEMENTS)

P. M. PEAK HOUR (4:30-5:30pm)

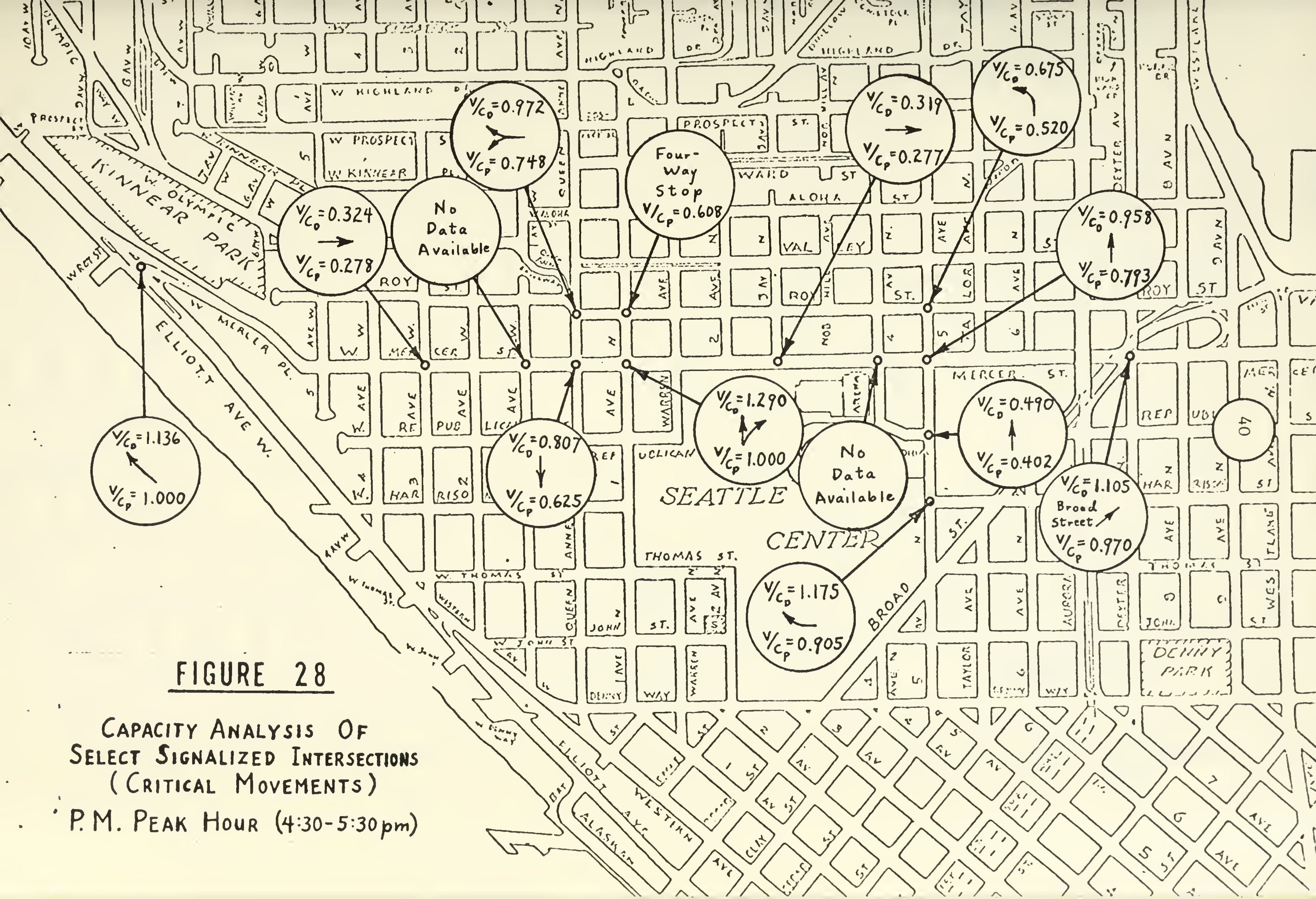


FIGURE 28

CAPACITY ANALYSIS OF SELECT SIGNALIZED INTERSECTIONS (CRITICAL MOVEMENTS)

P.M. PEAK HOUR (4:30-5:30pm)

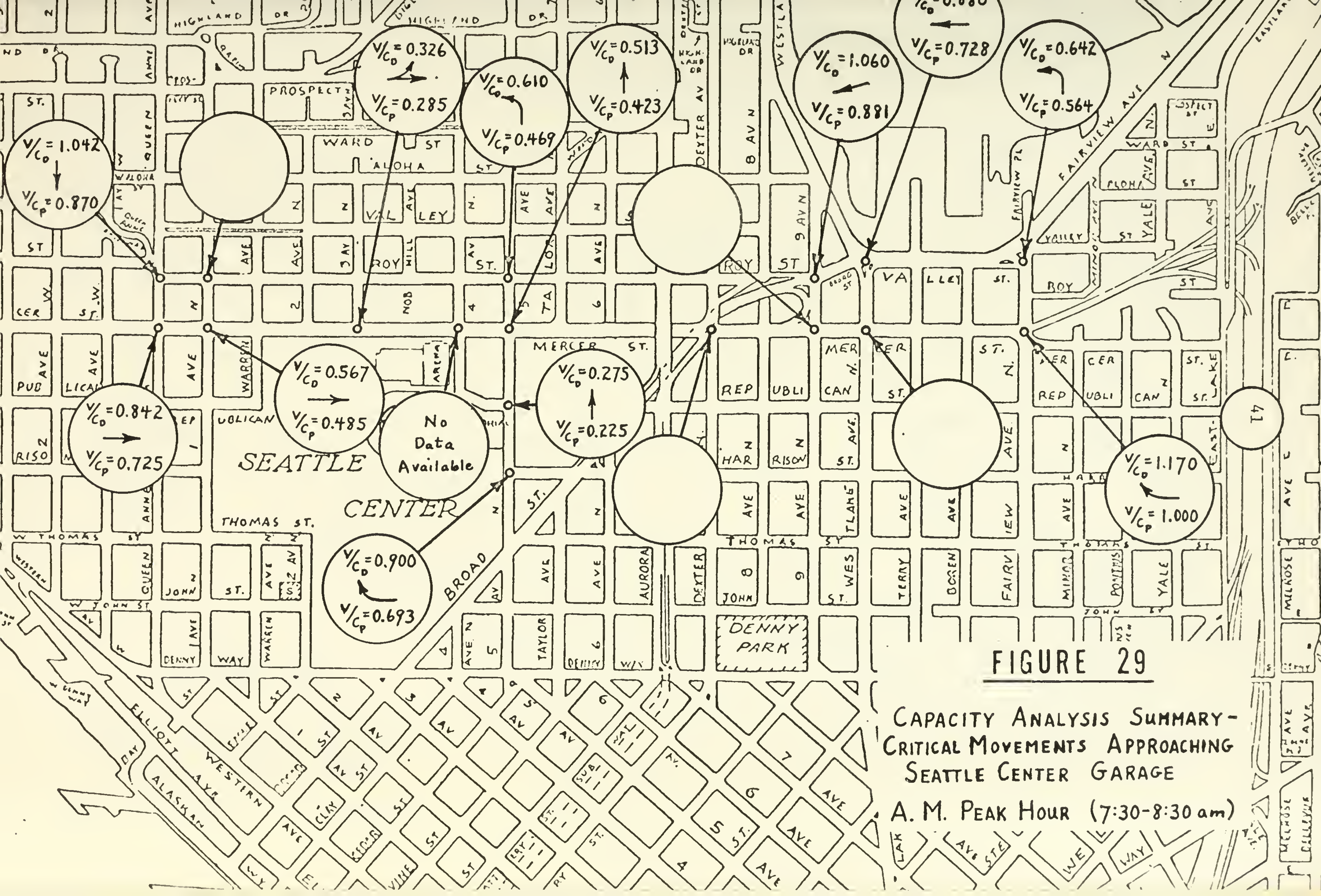


FIGURE 29

CAPACITY ANALYSIS SUMMARY - CRITICAL MOVEMENTS APPROACHING SEATTLE CENTER GARAGE

A. M. PEAK HOUR (7:30-8:30 am)

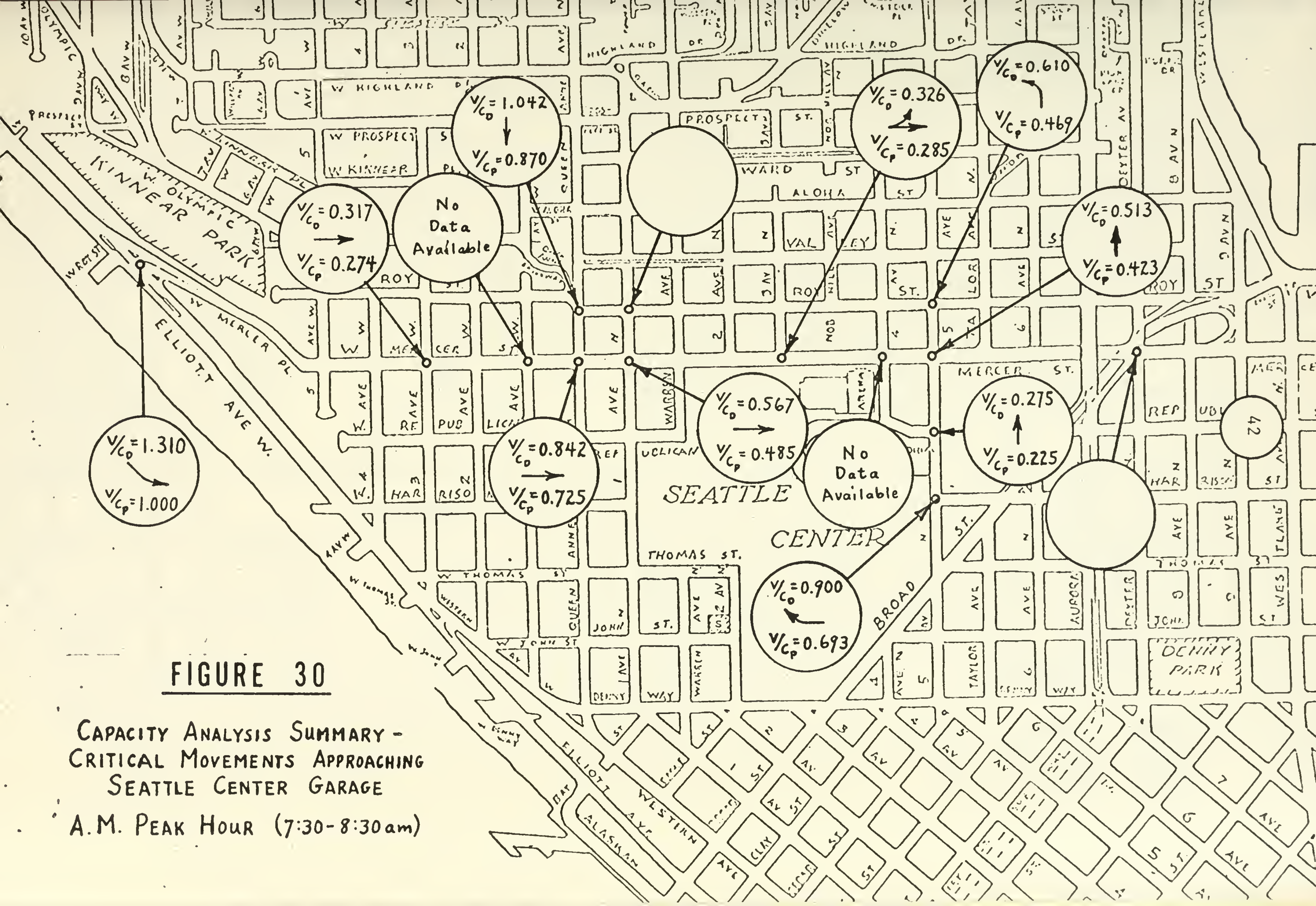


FIGURE 30

Capacity Analysis Summary - Critical Movements Approaching Seattle Center Garage

A.M. Peak Hour (7:30-8:30am)

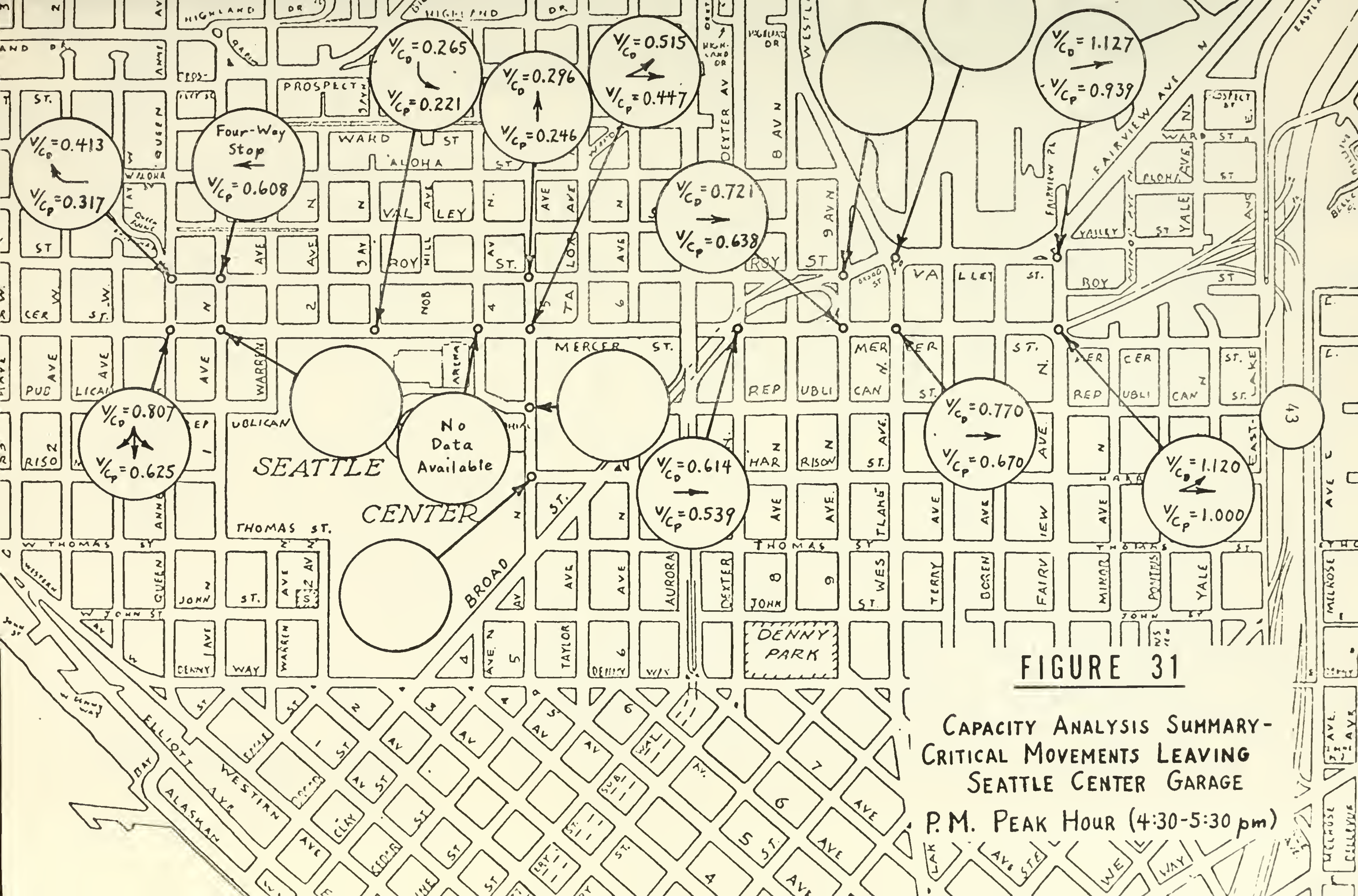


FIGURE 31

Capacity Analysis Summary - Critical Movements Leaving Seattle Center Garage

P.M. Peak Hour (4:30-5:30 pm)

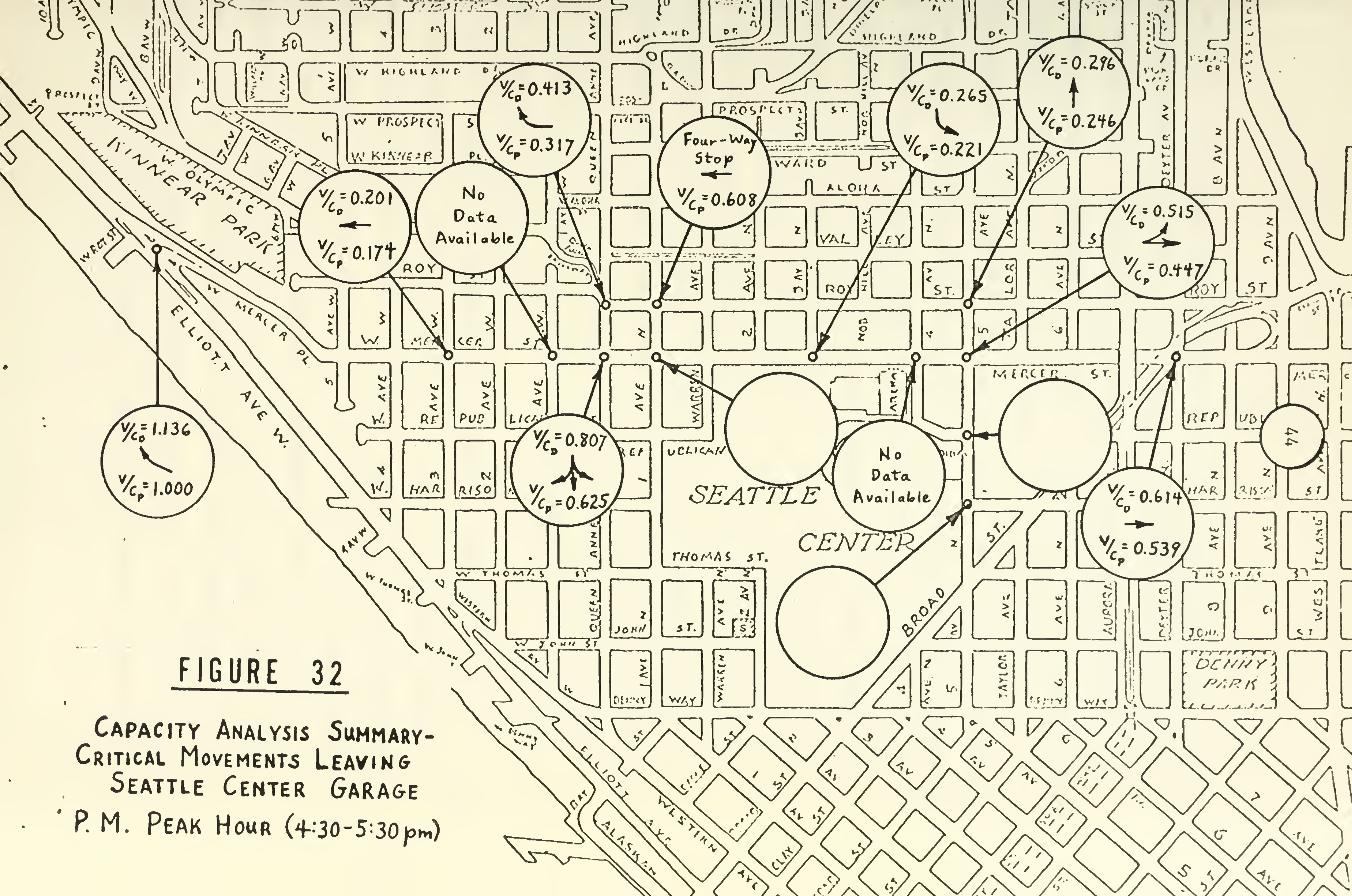


FIGURE 32

CAPACITY ANALYSIS SUMMARY-
CRITICAL MOVEMENTS LEAVING
SEATTLE CENTER GARAGE
P. M. PEAK HOUR (4:30-5:30 pm)

movement towards the Seattle Center in the morning at each of the applicable intersections analyzed. A similar illustration is given for the PM peak hour in Figures 31 and 32, only for vehicle movement away from the Seattle Center Garage. From Figures 29 and 30, it can be seen that existing morning traffic volumes are such that the intersections of Fairview Avenue N. and Mercer Street and, also, Elliott Avenue W. and W. Mercer Place are presently operating at maximum possible capacity. The analysis at Elliott Avenue and W. Mercer Place is only a partial one in that a count of traffic through the intersection on Elliott Avenue is not available. It is quite possible that green time can be robbed from the through movement on Elliott and added to the left-turn movement onto W. Mercer Place so as to give the latter greater capacity and an acceptable level of service. To this end it is necessary that complete peak hour counts be taken at the intersection so that a full capacity analysis may be calculated. In view of the present operation of the intersection, however, it is concluded that no additional vehicles can be handled during the AM peak hour which approach from the north and desire to turn left onto W. Mercer Place.

With respect to the intersection of Fairview Avenue N. and Mercer Street, it is concluded that little can be done to improve the present operation during the morning peak so as to gain more capacity for the westbound right-turn movement. A glance at Figure 25 reveals that at that intersection both approaches and all vehicle movements along Mercer Street are presently operating at or near capacity. No green time can be taken from the eastbound flow and added to the westbound movement without seriously hampering the eastbound operation of Mercer Street at this point. The minimum green time for the north/south movement on Fairview is limited by pedestrian

movement across Mercer Street, therefore, nothing can be gained by taking time away from those approaches. In summary, it is concluded that no additional traffic, over and above the present level, can be successfully operated westbound through the intersection of Fairview Avenue N. and Mercer Street without some sort of approach widening or other major revision.

Referring again to Figure 29, it is shown that secondary capacity constraints exist at the intersection of 9th Avenue N. and Broad Street for traffic westbound from the freeway, and, also, for southbound traffic along Queen Anne Avenue N. at the corner of Queen Anne and Roy Street. Present volumes exceed the design capacities of these two intersections, however, additional vehicles can be handled at a reduced level of service.

Traffic movement along the various access routes during the PM peak hour is illustrated in Figures 31 and 32. Again, the intersections of Elliott Avenue W. and W. Mercer Place and Mercer Street and Fairview Avenue N. provide constraints to the existing capacity of two of the major outbound corridors. As before, a complete traffic count, and subsequent capacity analysis, might allow relief at Elliott and Mercer Place for the movement from Mercer Place north on to Elliott Avenue. However, comparison of Figures 27 and 31 show that no improvement can really be made at Fairview and Mercer, for both the eastbound and northbound approaches are presently operating at maximum possible capacity and any green time added to improve the eastbound flow must be subtracted from the northbound movement, thus severely hampering the operation along Fairview Avenue N.

A secondary constraint also exists during the afternoon peak hour for northeast bound traffic through the intersection of Fairview Avenue N. and Valley Street. Some vehicles can be expected to be attracted to the Center from the Fairview Avenue N. corridor and then return in the evening by the

same route. This particular intersection could offer serious problems if additional eastbound traffic is generated during the PM peak. However, the capacity analysis reveals that relief can be gained by adjusting the distribution of green time. The south approach is presently operating at a V/C_p of 0.543, therefore, it seems reasonable that some green time can be taken away from that approach and added to the eastbound movement.

ASSIGNMENT OF TRAFFIC GENERATED BY THE MONORAIL PROPOSAL ALONG THE DESIGNATED ACCESS CORRIDORS

The number of vehicles which can be attracted to the Seattle Center from a particular zip code origin is a function of three factors. First of all, the origin zip code must satisfy the third basic assumption of this study. Another factor is the percentage of total attraction that originates from each zip code area. A final consideration is the percentage of favorable responses received, as indicated by survey data, from each zip code origin. Table II summarizes the applicable data, with the final attraction estimate for each origin being listed in column G. The origin zip codes listed in Table II are taken from the Victor O. Gray downtown parking study. Several zip code origins, namely 98002, 98039, and 98201, are applicable to this feasibility study, however, they were not covered in the V. O. Gray report. As a result, the sum of column G, Table II, is 1461 vehicles, some 64 less than the previously estimated maximum attraction of 1525 cars. These remaining 64 commuters are assumed to originate from one of the three above listed zip code areas.

Using the data from Table II, corridor assignments are made for commuter traffic from each zip origin to the general vicinity of the Seattle

TABLE II

ESTIMATED MAXIMUM NUMBER OF VEHICLES THAT COULD POSSIBLY BE ATTRACTED TO THE SEATTLE CENTER FROM APPLICABLE ZIP CODE ORIGINS

Origin Zip Codes	(A) Total Attraction From V.O. Gray & Co. Surveys	(B) Percent Of Total - (A)/1495	(C) No. "Yes" Responses To Mono. Proposal	(D) No. "No" Responses To Mono. Proposal	(E) Percent "Yes" Responses - (C)/(C+D)	(F) Percent "Yeses" In Total Study Pop. - (B)x(E)	(G) Est. No. Of Veh. Attract. From Each Zip Area 4900 x (F)
004 (Bellevue)	64	4.28	1	1	50.00	2.14	105
011 (Bothell)	31	2.07	5	4	55.56	1.15	56
020 (Edmonds)	53	3.55	3	7	30.00	1.07	52
033 (Kirkland)	58	3.88	4	9	30.77	1.19	58
036 (Lynnwood)	23	1.54	3	4	42.86	0.66	32
043	15	1.00	3	1	75.00	0.75	37
052 (Redmond)	12	0.80	1	3	25.00	0.20	10
072 (Woodinville)	4	0.27	0	1	0.00	0.00	0
102	206	13.78	7	22	24.14	3.32	163
103	107	7.16	3	10	23.08	1.65	81
105	104	6.96	5	13	27.78	1.93	95
107	105	7.02	3	10	23.08	1.62	79
109	83	5.55	6	5	54.55	3.03	148
115	140	9.36	10	32	23.81	2.23	109
119	75	5.02	6	7	46.15	2.32	114
122	42	2.81	0	5	0.00	0.00	0
125	72	4.82	1	6	14.29	0.69	34
133	68	4.55	2	13	13.33	0.61	30
155	83	5.55	4	10	28.57	1.59	78
177	48	3.21	5	9	35.71	1.15	56
199	102	6.82	10	17	37.04	2.53	124
TOTAL	1495	100.00	82	189	30.26		

Center. The results of this vehicle assignment is tabulated in Table III. Summing Column C, the previously estimated total of 1525 vehicles is checked. Column D, Table III, is an adjusted corridor assignment total based on the assumption that only 1000 vehicles would be attracted instead of the previously discussed 1525. A figure of 1000 vehicles is rather arbitrary at this point, however, detailed discussion is presented in Chapter IV which establishes 1000 as the most desirable level of attraction for the extended Monorail system. At any rate it is estimated, as shown in Table III, that 445 of the attracted commuter vehicles can be expected to leave the I-5 freeway at the Mercer Street exit enroute to the Seattle Center Garage. Another 176 cars can be expected to travel the Elliott Avenue W. / 15th Avenue N.W. corridor and turn towards the Seattle Center at W. Mercer Place. An additional 125 will use Aurora Avenue N., while 107 vehicles travel the Fairview Avenue N. / Valley Street / Broad Street route. Finally, lesser amounts will filter off of Queen Anne Hill via W. Olympic Place, Queen Anne Avenue N., or Taylor Avenue N.

THE PROPOSED BAY FREEWAY

In an effort completely independent of a Monorail extension proposal, the City of Seattle's Department of Engineering has planned and designed a proposed Bay Freeway. The lay-out of the Bay Freeway proposal is shown in Figure 33. Briefly, the plan calls for an elevated freeway structure to connect at the existing I-5 ramps at one end, cross over the existing street system and return to grade at the intersection of 5th Avenue N. and Mercer Street and 5th Avenue N. and Roy Street. The main structure is only a little over a quarter of a mile in length, however, the Mercer Street and Roy Street

TABLE III

VEHICLE ASSIGNMENT ESTIMATES FOR DESIGNATED PROBABLE ACCESS ROUTES TO THE SEATTLE CENTER

Access Corridor	(A) Zip Code Origin	(B) No.of Veh. Table II-G	(C) Total	(D) Adjusted Total (C) x 1000/1525
W. Mercer Pl. / Elliott Ave. W.	107 1/3(119) 1/3(177) 199	79 38 28 124	269	176
Aurora Ave. N.	020 103 133 1/2(177)	52 81 30 28	191	125
Interstate - 5 Freeway	002 039 201 004 011 033 036 043 052 072 105 115 125 155	 64 105 56 58 32 37 10 0 95 109 34 78	678	445
Fairview Ave. N.	102	163	163	107
10th Ave. W. / W. Olympic Pl.	1/3(119)	38	38	25
Queen Anne Ave. N.	1/3(109) 1/3(119)	74 38	112	73
Taylor Ave. N.	1/2(109)	74	74	49
Denny Way	122	0	0	0
TOTAL		1525	1525	1000

ramps extend for approximately another half mile. The Bay Freeway provides, of course, direct access from Interstate-5 to a point one block east of the Seattle Center Garage. Eliminated are all of the bottlenecks previously discussed westbound along Mercer and, also, eastbound along Valley and Broad. Relief would also be afforded the flow of vehicles to and from Fairview Avenue N. at the junction of Fairview and Valley Street, for the presently heavy flow of traffic northbound on Fairview between Mercer and Valley would all but be eliminated by the new freeway.

The Bay Freeway was initially conceived to provide direct freeway access from Interstate-5 to a new, proposed domed stadium and multi-story garage at Seattle Center. Failure of the stadium location plans in the spring of 1970 necessitated a re-evaluation and re-design of the freeway. Design proposals and alternatives, including the fundamental question of the highway's continued need, were argued for most of the remaining portion of the year 1970. Finally, by mid-November, 1970, the plan shown in Figure 33 had been adopted, all required hearings had been conducted, and the City Council had considered and acted upon all individual hearings and comments. Today, approximately 1/3 to 1/2 of the right-of-way property had been acquired. Two court suits are still pending, one scheduled for October, 1971, and the other for December, 1971. Satisfactory settlement of these suits should allow acquisition of the remaining property and commencement of a three year construction program in March of 1972.

The estimated cost of the Bay Freeway project is 28 million dollars. A breakdown of the project funding is as follows:

I. $3,500,000 - 1960 Highway Bond Fund (City General Obligation)

II. $8,200,000 - Urban Arterial Street Fund (State Derived)

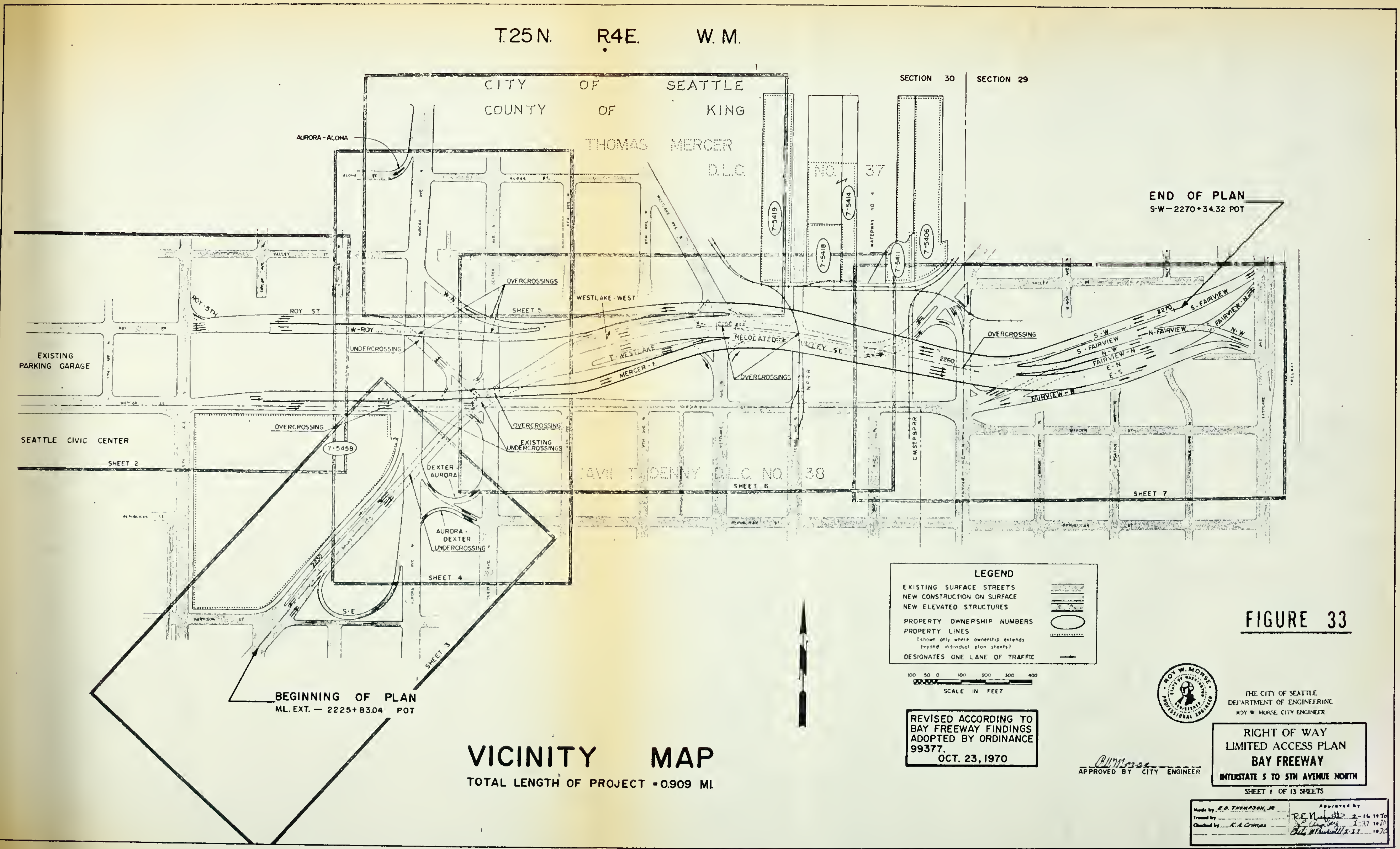

T.25 N.
R4E.
W. M.
CITY OF SEATTLE
COUNTY OF KING
THOMAS MERCER D.L.C. NO. 37
SECTION 30
SECTION 29
AURORA - ALOHA
END OF PLAN
S-W — 2270+34.32 POT
OVERCROSSINGS
WESTLAKE - WEST
SHEET 5
ROY ST
W-ROY
UNDERCROSSING
EXISTING PARKING GARAGE
E-WESTLAKE
MERCER - E
RELOCATED
VALLEY ST
OVERCROSSINGS
OVERCROSSING
S-FAIRVIEW
FAIRVIEW-N
N-W
N-FAIRVIEW
S-W
E-N
E-S
FAIRVIEW-E
SEATTLE CIVIC CENTER
SHEET 2
OVERCROSSING
EXISTING UNDERCROSSINGS
DEXTER AURORA
DENNY D.L.C. NO. 38
SHEET 6
SHEET 7
C M ST P & P RR
AURORA-DEXTER UNDERCROSSING
SHEET 4
S-E
SHEET 3
BEGINNING OF PLAN
ML. EXT. — 2225+83.04 POT
LEGEND
EXISTING SURFACE STREETS
NEW CONSTRUCTION ON SURFACE
NEW ELEVATED STRUCTURES
PROPERTY OWNERSHIP NUMBERS
PROPERTY LINES
(shown only where ownership extends beyond individual plan sheets)
DESIGNATES ONE LANE OF TRAFFIC
SCALE IN FEET
REVISED ACCORDING TO BAY FREEWAY FINDINGS ADOPTED BY ORDINANCE 99377.
OCT. 23, 1970
APPROVED BY CITY ENGINEER
THE CITY OF SEATTLE
DEPARTMENT OF ENGINEERING
ROY W. MORSE, CITY ENGINEER
RIGHT OF WAY
LIMITED ACCESS PLAN
BAY FREEWAY
INTERSTATE 5 TO 5TH AVENUE NORTH
SHEET 1 OF 13 SHEETS
VICINITY MAP
TOTAL LENGTH OF PROJECT = 0.909 MI.

FIGURE 33

III. $10,300,000 - Urban Arterial Board Fund

IV. $ 5,700,000 - State Highway Department

V. $ 200,000 - City General Fund

Since the cost estimate of the project was conducted several years ago and subsequent delays have eaten into available funds, it is suspected that the remaining obligated money might not allow construction of the entire project as planned. If such is the case and funds should be exhausted before the project is completed, construction of those portions colored in blue in Figure 33 would be delayed pending the authorization of additional money. Consequently, the existing Mercer Street corridor would continue to be utilized by westbound traffic until the Mercer-E ramp to the elevated freeway is completed.

Earlier in this chapter, it was concluded that no traffic in addition to the presently existing peak hour volumes can successfully be handled at the intersection of Fairview Avenue N., Mercer Street, and the Interstate-5 on/off ramps. The passage of 445 additional vehicles through that intersection during the peak hours, therefore, could never be accomplished. Because of this, it is doubtful that the previously assigned level of attraction to the Seattle Center Garage and Monorail system can actually ever be achieved. It is concluded, therefore, that construction of the Bay Freeway is absolutely essential to the success of the proposed Monorail extension and park-and-ride system. It is impossible for the additionally attracted vehicles to be handled during the peak hours by the existing street system between Interstate-5 and the Seattle Center Garage without some sort of widening or re-construction project. The Bay Freeway appears to offer the best solution, for it is a project that is already authorized, funded, and designed.

TRANSIT BUS/MONORAIL INTERFACE AT THE PROPOSED MERCER STREET TERMINAL

As shown in Figure 34, the Monorail extension proposal carries with it a plan to convert the northern-most lane of Mercer Street, between 3rd and 4th Avenues N., into two separate bus bays. Detailed discussion of the bus bay concept is presented in Chapters IV and V. At this point, therefore, it is sufficient to say that approximately 20 feet of the available 54 feet of street width would be usurped and no longer be available to through traffic along Mercer Street. The remaining 34 feet of street width could probably be configured into three lanes of 11 feet, 11 feet, and 12 feet.

The capacity of this revised two-block segment of Mercer Street can best be determined by an analysis of the west approach to the intersection of 4th Avenue N. and Mercer Street. Assuming a nominal G/C ratio of 0.60 (a conservative estimate) for the eastbound movement on Mercer Street, the capacity nomographs are again utilized to calculate a design capacity (C_D) of 2160 vph, and a maximum possible capacity (C_P) of 2420 vph. Looking back at Figure 23, the maximum traffic volume presently traveling that portion of Mercer Street is 1160 vehicles during the PM peak hour. Addition of 600 vehicles for local circulation arund the Parking Structure during the peak hour results in a maximum total of 1760 vehicles traveling along Mercer Street, between 3rd and 4th Avenues, during any single hour. This estimate results in a V/C_D ratio of 0.815 and a V/C_P ratio of 0.728. It is concluded, therefore, that sufficient capacity remains to handle the expected traffic on Mercer Street between 3rd and 4th Avenues N. even with a reduction of the width of Mercer Street to 34 feet.

FIGURE 34

Monorail Extension Feasibility Study

Alteration Of Mercer Street To Provide Transit Bus Bays

Eldon C. Schierman August 9, 1972

DATE	REV.	DESCRIPTION	APP
		Added Elev. @ 14 Points on Swing @ All Grid Lines	
		Added L.D. @ Col. Line 5-11 (Change order #7)	
		AS BUILT	

Monorail Extension Study

Alteration of Mercer Street to Provide Transit Bus Bays

Prepared by: Eldon C. Schierman, University of Washington

September 3, 1971

NORMAN G. JACOBSON, JR. & ASSOCIATES

CONSULTING ENGINEERS

11728 AURORA AVENUE SEATTLE 33, WASHINGTON EMerson 3-6900

APPROVED BY

SEATTLE CENTER

1500 CAR SELF-PARKING FACILITY

& PEDESTRIAN OVERPASS

NOB HILL AVE. & MERCER ST. SEATTLE, WASH.

A-4

6133

DESIGNED

DRAWN

LOWER LEVEL PLAN

CHECKED

DATE

CHAPTER IV

THE MONORAIL EXTENSION PROPOSAL

This chapter discusses in detail the required modifications to the Monorail, Parking Structure, and surrounding street system which are necessary in order to implement the proposal. Estimated additional costs are calculated and presented, as well as the expected monetary benefits, however a benefit-cost analysis of the various alternatives available is delayed until a later chapter.

THE PROPOSAL

Figure 16 (page 26) of the previous chapter illustrates roughly the general plan that is considered to have the best possibility of success. The plan features the continuation north along 5th Avenue of the easternmost Monorail (the red train). A 400 foot radius, simple curve is used to bend the single rail around to the west at Mercer Street and connect directly to the second parking level of the Garage. A new, elevated, Monorail passenger terminal is attached to the Mercer Street face of the Parking Structure and over-hangs the sidewalk and a portion of the existing Mercer Street. The existing pedestrian footbridge over-crossing Mercer Street would remain unchanged, as the Monorail extension and station are confined to the east of it.

Where the rail extension begins at the 5th and Thomas entrance to the Seattle Center, a switch of some sort must be constructed in the existing rail (see Figure 16). The development of monorail switches is still in a rather elementary state, as switching poses probably the biggest remaining technological problem still facing the promoters of monorail transit systems.

Several techniques have been suggested, but so far none of them have proven more than marginally successful. For example, a flexible aluminum beam is thought possible which is cantilevered at one end and moved back and forth in the horizontal plane to provide the switching action. However, it is difficult, if not impossible, to design a beam which is stiff enough to prevent undue deflections in the vertical plane and still flexible enough to allow sufficient bending in the horizontal plane. Another idea is a sliding table switch. The mechanism consists of an under-hanging table which can slide perpendicular to the direction of monorail travel. The table has two, short, fixed sections of rail on it which when aligned properly will cause a single incoming rail to connect with one of two exiting rails. This type of switching arrangement has serious short-comings in an elevated transit system such as the Seattle Monorail. An exorbitant amount of mass is required to support the switching table, a fact which makes the arrangement both expensive and unsightly for elevated structures. A final switching possibility is the insertion of a movable, rigid, straight-rail beam between columns # 6A and # 8 (see Figure 35). The presently existing beam is curved and forms a portion of the curve entering the Seattle Center Terminal. A new, straight beam would be pinned at column # 8 and would be movable in the horizontal plane. Of course, the insertion of a straight cord in a curved portion of track would necessitate relatively slow and careful train movement when negotiating that section of rail, however, such a limitation can be tolerated in this case. The normal operation of the red Monorail train would become the straight-through route of the straight beam switch. The curved route into the Seattle Center Terminal would only be negotiated once in the morning and once in the evening, as the existing terminal would serve

solely as a maintenance and storage bay for the red train. The straight beam concept is further favored due to the fact that a switch of this type is presently in operation as part of the Disneyland, California, monorail system. Thus, the technology has already been developed and proven successful. Figure 36 illustrates a sketch of what a straight beam switch might look like in the Seattle monorail beam.

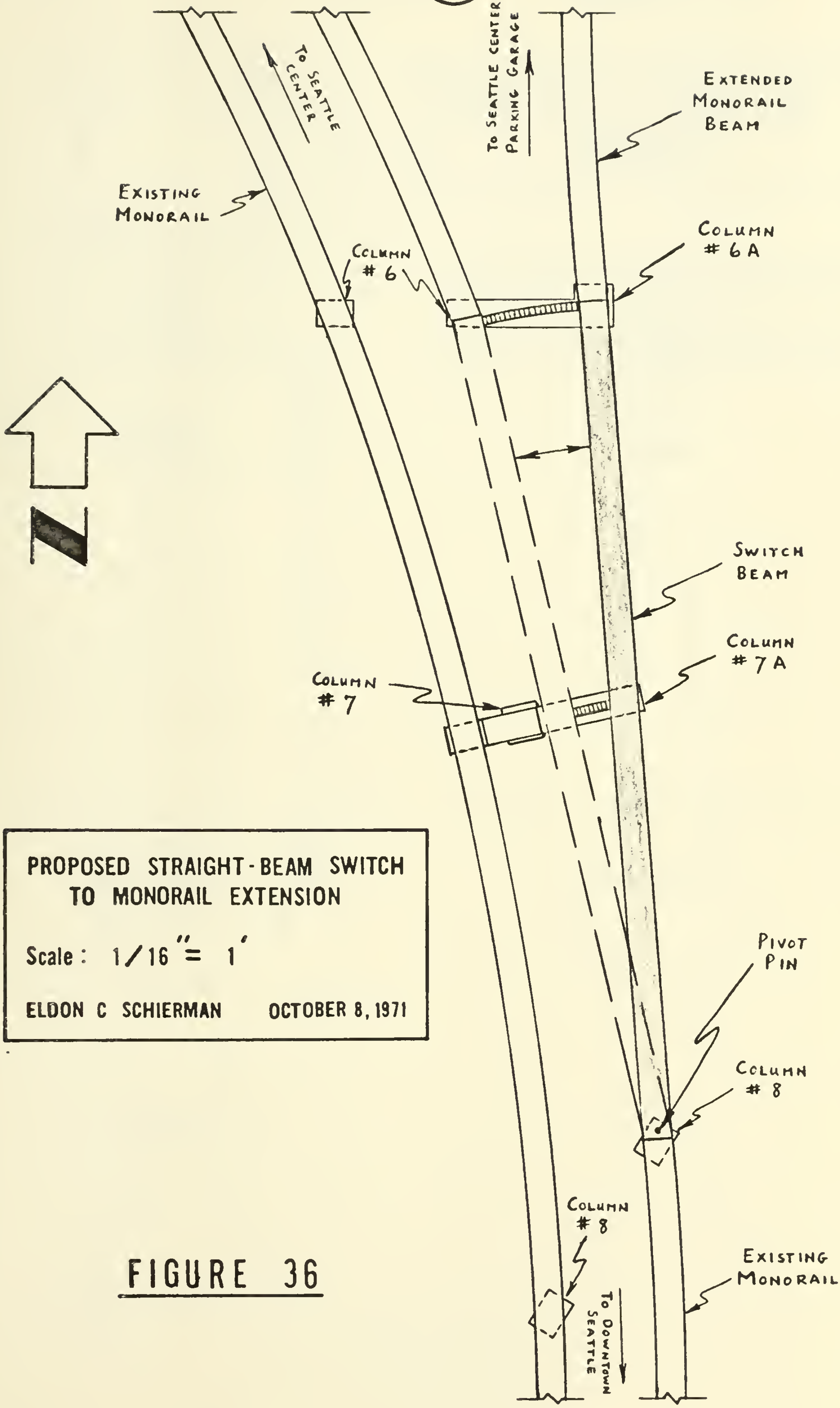
Referring again to Figure 35, a plan and vertical profile is laid out showing the route of the monorail extension. Columns A through K are standard concrete structures (as shown in Figure 37) and extend along the pedestrian sidewalk between 5th Avenue and the Seattle Center grounds. It is important to note that these columns do not encroach upon any of the existing 5th Avenue street width, and it is anticipated that the same number of traffic lanes as now presently exist would remain along 5th Avenue. Columns L, M, N, and O are standard structures supporting the rail as it curves over the vacant northeast corner of the Seattle Center.

As shown in Figure 35, colum P is placed in the middle of Mercer Street. Mercer Street is sufficiently wide at that point such that the existing four traffic lanes can be routed around the obstruction without a significant loss in street capacity. The lane width of the two existing outside lanes is 15 feet. By reducing the width of the outside lanes to 11 1/2 or 12 feet, sufficient width is gained to allow the placement of a 4 foot wide column, plus a foot or two on either side as clearance.

Column Q is a structural steel, upside-down "U" shaped support, spanning the special bus bay along Mercer Street (see Figure 34, page 55). An illustration of column Q is shown in Figure 38. Columns R and S are similar to columns A through P and are located in the sidewalk along Mercer Street.

SEATTLE WORLDS FAIR
CENTURY 21 EXPOSITION
DEVELOPMENT PLAN
From A Drawing Prepared By:
PAUL THIRY, F.A.I.A., Primary Architect
Scale: 0 80 160

FIGURE 35



PROPOSED STRAIGHT-BEAM SWITCH TO MONORAIL EXTENSION

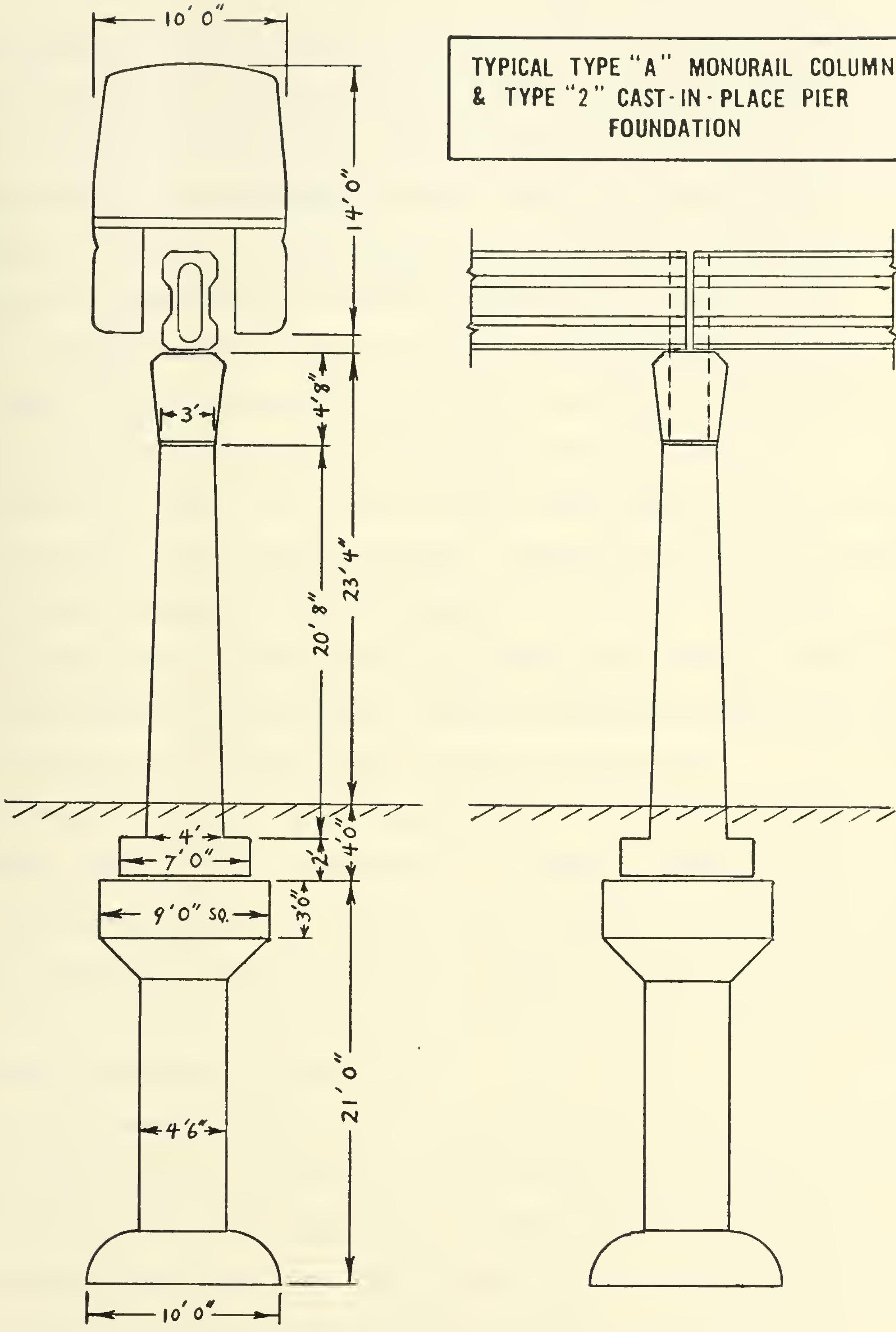
Scale: 1/16" = 1'

ELDON C SCHIERMAN OCTOBER 8, 1971

FIGURE 36

FIGURE 37

TYPICAL TYPE "A" MONORAIL COLUMN & TYPE "2" CAST-IN-PLACE PIER FOUNDATION



The street-width of Mercer along the south face of the parking structure is narrowed by one-half of a foot so that the columns along Mercer Street do not encroach into the street, but, again, no traffic lanes are lost because of the installation of the monorail support columns. As discussed briefly in Chapter III, one lane of Mercer Street is converted into a bus bay with facilities for transit passenger loading, unloading, and transfer to the Monorail. Mercer would then have three lanes of through traffic from the point where it starts one-way operation at 1st Avenue North until it widens to four lanes at the intersection of 4th Avenue North.

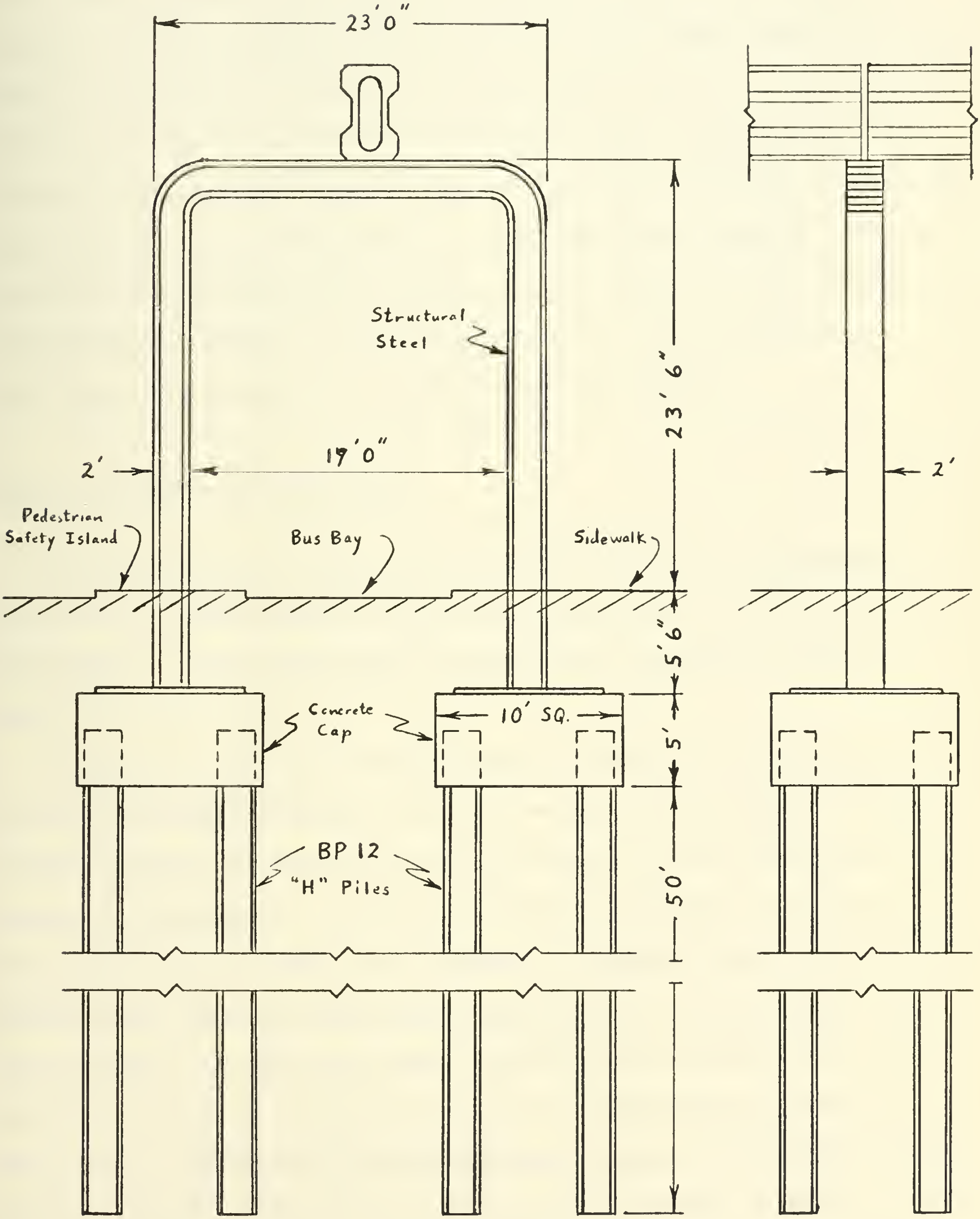
Columns T, U, and V are "T" shaped columns which support not only the monorail but, also, the passenger terminal. Detailed sketches of the columns, as well as the proposed new monorail terminal are found in the appendix. Column V would support the new end of the extended rail, however, construction of the rail and terminal would be such that future extension west along Mercer Street would be possible with only minor modifications.

Referring again to Figure 35, columns 6A and 7A are shown as additions to existing supports 6 and 7 respectively. No suggested design is given here, for the possibilities are numerous, and a solution can only be arrived at after completing a detailed structural analysis of the two existing monorails, the new rail which commences with support 6A, and the movable switch beam which spans between columns 6A and 8.

The new passenger terminal for the monorail is envisioned as an elevated structure which would be joined to the Parking Garage as an extension of the second parking level. The terminal would overhang the sidewalk and one of the existing traffic lanes along Mercer Street (the plan calls for conversion of this traffic lane into a reserved transit bus bay). Support of the

FIGURE 38

COLUMN "Q" & TYPICAL TYPE "1" DRIVEN-PILE FOUNDATION



terminal is provided primarily by columns T, U, and V and also by the existing parking structure. The terminal is accessible directly from inside the Garage at the second parking level and, also, from the street via a suspended pedestrian platform. The platform is hung beneath the rail and main loading platforms in order to provide direct passenger access to and from the sidewalk and, also, from the Garage's first parking level. One fight of escalator provides movement from the sidewalk up to the pedestrian underpass, while pre-cast concrete stairs provide access from the underpass to both main passenger loading platforms. Refer to Appendix D for a detailed discussion and illustrative drawings of the proposed monorail terminal.

COSTS AND BENEFITS OF THE PROPOSAL

The total capital outlay, as expressed in 1971 dollars, for construction of the proposed monorail extension and modification is estimated to be $955,000.00. A cost break-down by various general categories is shown in Table IV.

Additional costs, primarily operational in nature, would also be incurred if the proposed monorail extension was actually constructed. These charges represent the added cost of doing business for both the Parking Garage and the Monorail as a result of intensified facility utilization. The figures listed in Table V are expressed as estimated monthly costs over-and-above the existing Monorail and Garage operation and maintenance costs. From the table, an additional monthly operating cost of $12,264.00 is incurred as a result of the monorail extension. This figure includes such costs as: (1) additional labor and equipment to operate a full garage during the day (7:00 AM - 7:00 PM), (2) additional train personnel to operate both

TABLE IV

COST ESTIMATE SUMMARY FOR THE PROPOSED MONORAIL EXTENSION

Work Category	Estimated Cost
I. Footings (Both Driven Pile and Cast-in-Place Pier Foundations)	$ 241,400.00
II. Cast-in-Place Concrete Monorail Beam Support Pedestals	$ 101,700.00
III. Monorail Beam Extension	$ 258,800.00
IV. Monorail Beam Switching	$ 40,700.00
V. Monorail Terminal ("T"-Columns T,U, and V not included)	$ 184,400.00
VI. Miscellaneous Costs	$ 74,000.00
VII. Architect and Design Engineering	$ 54,000.00
TOTAL COST OF PROJECT	$ 955,000.00

TABLE V(a)

EXISTING AND ESTIMATED ADDITIONAL RECURRING MONTHLY OPERATION COSTS FOR THE MONORAIL AND SEATTLE CENTER PARKING GARAGE

Work Item	Ave.Exist.Monorail Oper.		Est.For Extend.Mono.Oper.	
	Average Time & Rate	Monthly Cost($)	Average Time & Rate	Monthly Cost($)
Monorail Operation:				
Inspector	13hrs@$5.2801/hr	68.64	13hrs@$5.2801/hr	68.64
(Fringe Costs)	@ 30.19%	20.72	@ 30.19%	20.72
Subtotal:		89.36		89.36
Operators	450hrs@$4.50/hr	2025.00	350hrs@$4.50/hr	1575.00
(Fringe Costs)	@ 29.93%	606.08	@ 29.93%	471.40
Subtotal:		2631.08		2046.40
Overhead:	@ 17.2%	467.92	@ 17.2%	367.35
Total Operator Cost		3188.36		2503.11
Monorail Maintenance				
Coach Svc Fore II	176hr@$5.9943/hr	1055.00		
Co Svc Fore I, Sw	176hr@$5.7149/hr	1005.82		
Auto Machinist	280hr@$4.7989/hr	1343.69	70hrs@$4.7989/hr	335.92
Auto Mach,Ldman	70hrs@$5.6152/hr	393.06		
Auto Mach,Swing	240hr@$4.8989/hr	1175.74		
Auto Mach,Sw,Ldman	64hrs@$5.7152/hr	365.77		
Auto Mach,Grave			176hr@$5.0489/hr	888.61
Auto Mach,Grave (Shift From Present Day Shift)			176hrs@ an addit $0.25/hr	44.00
Auto Mach,Gr,Ldman			176hr@$5.8652/hr	1032.28
Misc Repairmen		12.63		
(Fringe Costs)	@ 30.19%	1615.68	@ 30.19%	694.61
Subtotal:		6967.39		2995.42
Overhead	@ 17.2%	1198.39	@ 17.2%	515.21
Total Maint Labor Cst		8165.78		3510.63
Material Costs		250.00		300.00
Handling	@ 18%	45.00	@ 18%	54.00
Total Material Costs		295.00		354.00

TABLE V(b)

EXISTING AND ESTIMATED ADDITIONAL RECURRING MONTHLY OPERATION COSTS FOR THE MONORAIL AND SEATTLE CENTER PARKING GARAGE- (CONTINUED)

Work Item	Ave.Exist.Monorail Oper.		Est.For Extend.Mono.Oper.	
	Average Time & Rate	Monthly Cost($)	Average Time & Rate	Monthly Cost($)
Misc Categories		40.00		50.00
Cashier	40hrs@$4.6367/hr	185.47		
(Fringe Costs)	@ 30.19%	55.99		
Total Cash Counting Costs		241.46		
Beam Maintenance (Average)		522.31		500.00
Electrical Energy Usage (Average)		950.00		1100.00
Total Monthly Costs For Monorail Oper. & Maintenance		$13,402.91		$8017.74
Garage Operation				
Garage Attendants			1056hrs@$3.50/hr	3696.00
Tri-Wheel Scooter				550.00
Total Garage Operating Costs		6243.91		4246.00
Total Cost Of System Operation		$19,643.83		$12,263.74

trains simultaneously on week-days, (3) additional maintenance personnel, equipment, and parts necessary to properly maintain both trains, and (4) increased electrical energy usage due to the operation of both trains during the week. In comparison, the existing average monthly cost of operating and maintaining one train per week, and operating the Garage virtually empty during the day, is $19,644.00 per month.

The additional operating cost of $12,264.00 per month is expanded to an expected annual cost. For this calculation, an annual interest rate of 5% is assumed. Also assumed is the monthly compounding of interest, or twelve equal periods during the year. To find the annual cost, the formula:

$$(1) \qquad F = A\,(f/a)\,{}^{i}_{n}$$

is used where:

a). F = annual cost (future worth)

b). A = monthly cost ($12,264.00)

c). i = interest rate (5% annually, or 0.4167% monthly)

d). n = number of periods (12 per year)

The factor $(f/a)\,{}^{i}_{n}$ is calculated using the formula:

$$(2) \qquad (f/a)\,{}^{i}_{n} = \frac{(1 + i)^{n} - 1}{1} \qquad [3]$$

where all factors are the same as listed above. Solving the relationship yields the solution:

$$(3) \qquad (f/a)\,{}^{0.4167\%}_{12} = 12.279$$

Finally, the annual cost is calculated by using (1) and (3).

(4) $F = (\$12,264.00)\ (12.279) = \$149,500.00$ per year

The annual figure calculated in (4) does not include, of course, the annual cost of repaying bonds used in capitalizing the additional construction. Assuming a 6% interest rate for municipal revenue bonds and a 30 year period to maturity, the annual capital cost is calculated using the relation:

$$(5) \qquad A = P\ (a/p)\ {}^{i}_{n}$$

where:

a). A = annual cost

b). P = present worth (single sum = \$955,000.00)

c). i = interest rate (6% annually for municipal bonds)

d). n = number of periods (30 years)

The factor $(a/p)\ {}^{6\%}_{30\ \text{years}}$ is derived from the relationship:

$$(6) \qquad (a/p)\ {}^{i}_{n} = \frac{i\ (1 + i)^{n}}{(1 + i)^{n} - 1} \qquad [3]$$

and is calculated to be:

$$(7) \qquad (a/p)\ {}^{6\%}_{30\ \text{years}} = 0.07265$$

$$(8) \qquad A = (\$955,000.00)(0.07265) = \$69,380 \text{ per year}$$

The total annual cost of the proposal, of course, is the sum of (4) and (8). This summation results in:

$$(9) \qquad \text{Cost}_{\text{total}} = \$149,500.00 + \$69,380.00 = \$218,880.00 \text{ per year}$$

The net benefits which can be figured for the Parking Garage and Monorail system total \$15,850.00 per month. This value represents the additional revenue that should be generated directly as a result of the extension. It is assumed that 1000 is the maximum desirable number of vehicles using the garage for all-day parking. This would allow between 400 and 500 spaces to remain available during the day to serve the Center. In addition it is assumed that the commuting vehicle occupancy rate is 1.3 persons per vehicle. In other words it can be anticipated that 300 commuters, in addition to the 1000 vehicle drivers, would be riding the Monorail. From Figure 15 a maximum monthly charge of \$13.75 should attract 1000 vehicles to the Seattle Center Garage. Multiplying 1000 veh. x \$13.75 / month / veh. yields an income of \$13,750 / month. Since the 300 additional commuters must also ride the Monorail, it is assumed that they would be charged about half of the regular monthly fee, or \$7.00 per month. This figures to be about \$.15 per ride on the Monorail for each car-pool passenger. It is not desirable to discourage car-pooling by charging the passengers an unreasonable amount to use the proposed system. \$7.00 per month provides additional income from these Monorail users but still is considerably less than the cost of other forms of transit or of parking downtown. Multiplying \$7.00 / month / rider x 300 riders results in a benefit of \$2,100 per month. Summing the benefits yields a monthly income of \$15,850.00.

The annual direct benefit from the proposal is calculated using the formula:

$$(10) \qquad F = A\,(f/a)\,{}^{i}_{n}$$

where:

a). F = annual benefit

b). A = monthly benefit ($15,850.00)

c). i = interest rate (5% annually, or 0.4167% monthly)

d). n = number of periods (12 per year)

The factor $(f/a)\,{}^{0.4167\%}_{12}$ is calculated as before and is equal to 12.279. Solving for the annual benefit:

$$(11) \qquad F = (\$15{,}850.00)\ (12.279) = \$194{,}625.00 \text{ per year}$$

$$(12) \qquad \text{Benefits}_{\text{total}} = F = \$194{,}625.00 \text{ per year}$$

Using the previously calculated figures for annual total cost ($218,880.00) per year) and annual total benefit ($194,625.00 per year), a benefit - cost ratio of 0.89 is obtained. A B/C ratio less than 1.00 indicates that the proposal does not appear to be economically feasible based on the assumed rates of interest, assumed 30 year bonding, and the assumed non-availability of funds other than that generated by the system itself. A second look at these assumptions, plus an analysis of their effects on the benefit-cost outlook, is discussed further in Chapter VI.

CHAPTER V

OPERATION OF THE NEW SYSTEM

In addition to designing a project that is economically feasible to to construct and maintain, it is necessary to design a system that is physically possible to operate. It is the purpose of this chapter to discuss the operating characteristics and limitations of the facilities involved and to detail a recommended method of operation which is felt to be both feasible and practical. Included in this chapter are alterations to the existing Seattle Transit system so as to integrate the operation of the Monorail with that of the transit buses.

THE MONORAIL

A proposed week-day schedule for the red Monorail train is shown in Table VI. Eighty-eight round trips per day during the working week are scheduled, with the train not operating on weekends or holidays. Round-trips are scheduled every six minutes from 7:00 AM until 9:00 AM. This is possible by assuming the same rates of acceleration and deceleration and maximum speeds that were observed during the '62 World's Fair. From Figure 39 it can be seen that the elapsed time for a one-way trip over the existing 1.2 mile route is 105 seconds and the maximum obtainable speed is 53 m.p.h.

An additional 1270 feet is added to the one-way Monorail trip by the extension of the rail. This figure is arrived at by subtracting 675 feet of existing rail (from the start of the switch beam at column 8 to the end of the run at the terminal) from the 1945 feet of new rail (from column 8 to the end at the new terminal). It can be assumed that the additional 1270 feet would be traveled at the train's top speed of 53 m.p.h., or 77.733 ft.

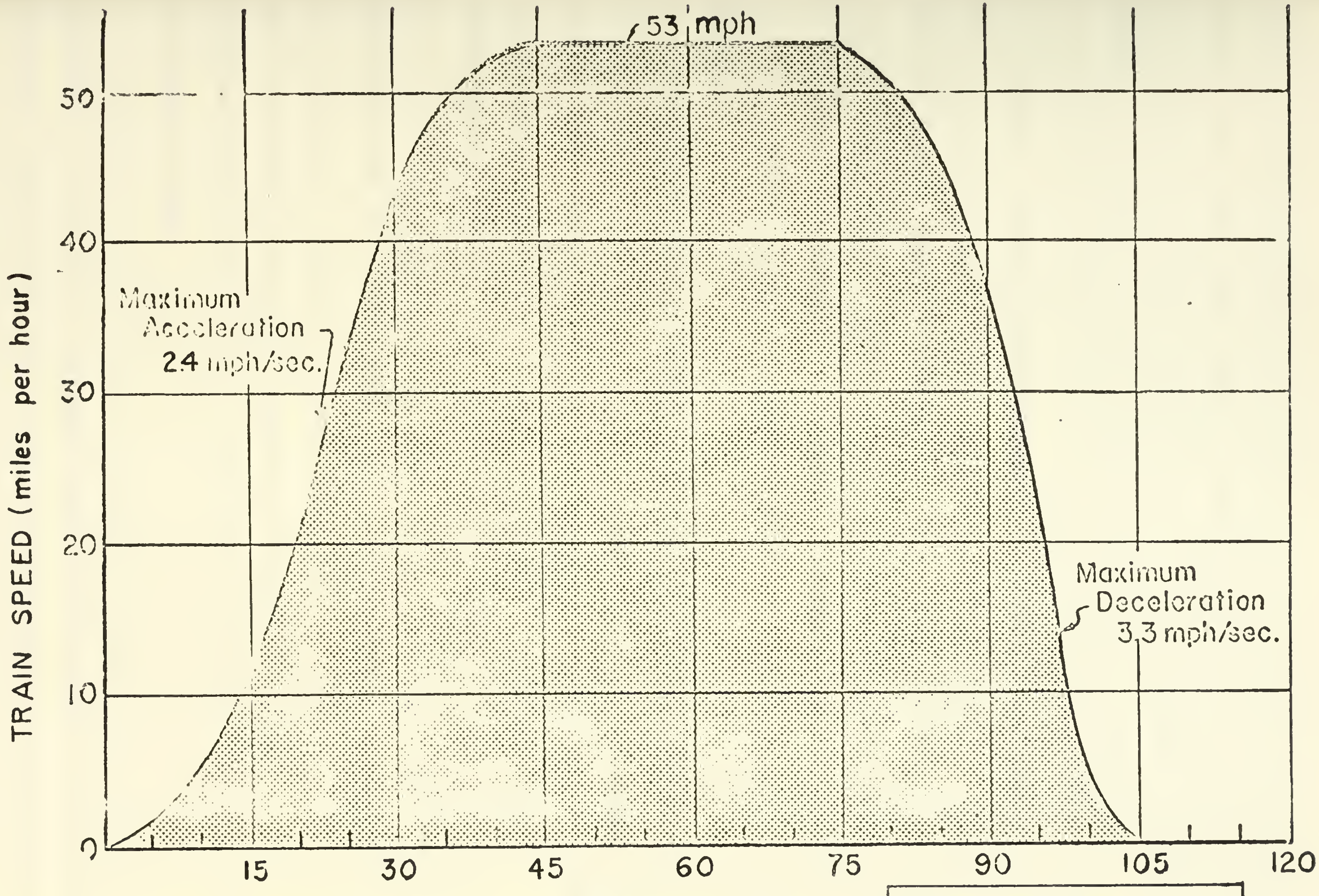
TABLE VI

MONORAIL EXTENSION PROPOSAL RECOMMENDED OPERATING SCHEDULE

Parking Structure Terminal To Downtown Westlake Mall Terminal

Data:
Train Capacity - 124 seats, 450 total (with standees)
Route Length - 1.44 miles
One - Way Travel Time - 125 seconds (2min5sec=2.08min)
Station Waiting Time - 55 seconds (0.92min)
Total One - Way Trip - 180 seconds (2.08min + 0.92min = 3.00)
Total Number of Round Trip Runs During The Weekday - 88

Leave Parking Structure Station	Leave Westlake Mall Station	Leave Parking Structure Station	Leave Westlake Mall Station	Leave Parking Structure Station	Leave Westlake Mall Station
7:00am	7:03am	11:30am	11:35am	5:06pm	5:09pm
7:06	7:09	11:40	11:45	5:12	5:15
7:12	7:15	11:50	11:55	5:18	5:21
7:18	7:21	12:00pm	12:05pm	5:24	5:27
7:24	7:27	12:10	12:15	5:30	5:33
7:30	7:33	12:20	12:25	5:36	5:39
7:36	7:39	12:30	12:35	5:42	5:45
7:42	7:45	12:40	12:45	5:48	5:51
7:48	7:51	12:50	12:55	5:54	5:57
7:54	7:57	1:00	1:05	6:00	6:03
8:00	8:03	1:10	1:15	6:06	6:09
8:06	8:09	1:20	1:25	6:12	6:15
8:12	8:15	1:30	1:37.5	6:18	6:21
8:18	8:21	1:45	1:52.5	6:24	6:27
8:24	8:27	2:00	2:07.5	6:30	6:37.5
8:30	8:33	2:15	2:22.5	6:45	6:52.5
8:36	8:39	2:30	2:37.5	7:00	7:07.5
8:42	8:45	2:45	2:52.5	7:15	7:22.5
8:48	8:51	3:00	3:07.5	7:30	7:37.5
8:54	8:57	3:15	3:22.5	7:45	7:52.5
9:00	9:07.5	3:30	3:37.5	8:00	8:07.5
9:15	9:22.5	3:45	3:52.5	8:15	8:22.5
9:30	9:37.5	4:00	4:07.5	8:30	8:37.5
9:45	9:52.5	4:15	4:22.5	8:45	8:52.5
10:00	10:07.5	4:30	4:33	9:00	9:07.5
10:15	10:22.5	4:36	4:39	9:15	9:22.5
10:30	10:37.5	4:42	4:45	9:30	9:36.5
10:45	10:52.5	4:48	4:51	9:45	9:52.5
11:00	11:07.5	4:54	4:57	10:00pm Secure Train For Night	
11:15	11:22.5	5:00	5:03		



Observed Speed-Time Curve For Seattle Monorail Operation From Downtown Terminal To World's Fair Site

FIGURE 39

figure from: "SEATTLE MONORAIL" by Martin Ekse, et al; Un. of Washington; October, 1962

Eldon C Schierman August 28, 1971

per sec. Dividing 1270 ft. by 77.733 ft. per sec. yields to 16.338 seconds of additional travel time. Adding 16.338 seconds to 105 seconds gives a total travel time over the extended route of 121.338 seconds, or say 125 seconds. Observation of train operation during the Fair revealed an average passenger loading time of 25 seconds and passenger unloading time of 30 seconds. These times were observed at a time when the Monorail trains were operating at near capacity. Adding the two figures gives a minimum required station time of 55 seconds in order to empty and then fully load a train. Adding the 55 seconds of station time to the 125 seconds of travel time results in 180 seconds, or 3 minutes, of elapsed time for a one-way trip. A 3 minute one-way trip makes possible the 6 minute round-trip schedule.

From 9:00 AM until 11:30 AM, the red Monorail would operate on a schedule specifying a round trip every fifteen minutes. This schedule is similar to the one that is presently in operation. From 11:30 AM to 1:30 PM, the train would make a run every ten minutes. The more intensive schedule during the noon hours allows the businessman to reach his car at the Seattle Center and use it for lunch. From 1:30 PM to 4:30 PM and then again from 6:30 PM to 10:00 PM the Monorail would operate on the fifteen minute schedule. During the evening rush; that is, from 4:30 PM to 6:30 PM, the six minute round-trip schedule would again be in effect. The schedule outlined above results in eighty-eight round trips a day for the red Monorail train.

The Seattle Monorail train, as presently configured, has a seating capacity of 124 seats, and a maximum capacity with standees of 450 passengers per train. During the rush hours, with the train making ten trips per hour

(one every six minutes), the passenger carrying capacity in each direction figures to be 1240 seats and 4500 total. The 1240 seats per hour can very nearly satisfy the estimated 1300 people who would drive or ride an automobile to the Garage during the peak commuting hour.

The mechanics of Monorail fare collection for monthly parking presents somewhat of a problem. The regular Monorail fee would remain at 25¢ for a one-way trip, however the monthly parkers, and their riders, have the option of purchasing Monorail fares by the month. A method of operation which could be used is the issuance of a small book of tickets to each individual as he pays his monthly parking fee. The booklet would contain 44 one-way tickets, or however many are needed to allow a round trip for each working day of that month. The tickets could be colored so as to not be transferable from month to month. Car pool riders could purchase a booklet for the previously mentioned $7.00 per month fee. Thus, a properly colored ticket, or the regular fare in cash, must be presented for each ride on the monorail.

THE PARKING GARAGE

The monthly parking sticker issued to daytime parkings would only be valid from 7:00 AM until 6:30 PM on working days only. This fact would be emphasized to each monthly parker. The parking sticker would not be valid after 6:30 PM or on week-ends.

The Garage presently operates with two entrance/exits. One each is located at mid-block on both 3rd Avenue North and 4th Avenue North. The entrances are each two lanes wide. Street signs would direct the stickered cars to one of the two entrance lanes. They would be waved through without stopping by the attendant upon visual observation of a valid parking sticker. The non-stickered vehicles would be directed by signs to the other entrance

lane where they would have to stop and pay the regular $1.00 per day parking fee to an attendant. A stub receipt of payment would be attached to the car. During the day the stickered cars could come and go as they please without further payment. However, the existing 50¢ reparking fee for non-stickered cars would remain in effect.

At 6:30 PM the monthly parking sticker would no longer be in effect. A manual survey of the garage would be conducted at this time by Garage personnel. It is anticipated that the accumulation of vehicles in the Garage at that time would be at its lowest point, for most of the daytime parkers would have already left and the rush of people attending nighttime attractions at the Center would not yet have begun. The survey would identify those cars with monthly stickers remaining in the Garage which do not also exhibit a stub for having payed the $1.00 evening parking fee. A separate, two-part ticket would be used by the attendant in such cases. One part would be left on the car under the window wiper. The other, matching half would be retained by the attendant with the vehicle license number stamped on the back. Upon returning to his car, the individual would present his portion of the ticket to the nearest cashier (one at each entrance and one on the second level near the Monorail terminal), pay the $1.00 fee, and receive in return the other half of the ticket with the license number on it. At the end of the evening, those tickets remaining allow the offenders to be identified by means of the vehicle license number and so notified of their delinquency. The need for such a monitoring system is obviously to prevent monthly daytime parkers from abusing their privilege and keeping their cars in the garage at night when the Garage otherwise experiences full usage.

The exiting from the Garage would be by one of the two available two-lane exits and would be basically unattended (except when necessary to

direct traffic so as to keep things flowing smoothly). No fees or ticket stubs would be collected from the vehicles as they exit.

No modifications are anticipated or recommended to the entrance and exits of the Garage. In fact, operation of the existing automatic gate controlling one lane of the entrance should be discontinued and the equipment removed if desired. Cashier's booths presently exist at each main entrance/exit, and only minor modifications are necessary in order to provide a cashier's window. A third booth would have to be procured and installed on the second parking level. Also, a three-wheeled motor scooter would be provided on a full time basis to assist attendants in monitoring the Garage.

ALTERATIONS TO THE SEATTLE TRANSIT SYSTEM

A glance back at Figure 34 (page 55) shows the lay-out of two bus bays and passenger loading safety islands along Mercer Street, between 3rd and 4th Avenues North. The outside traffic lane along Mercer Street is obstructed because of the pedestrian undercross suspended underneath the main Monorail terminal platform. Vertical clearance from the bottom of the undercrossing to the street level is only ten feet (see Figure D-8, appendix), which is insufficient to allow through traffic along that lane of Mercer Street. Thus, the special bays allow buses to enter and discharge/load passengers and remain out of the way of the through traffic flow. The channelization and raised islands direct the remaining three through-lanes around and clear of all overhanging obstructions.

Creation of special bus bays along Mercer Street allow the possibility of diversion and possible termination of some of the existing regular transit

bus routes which now pass near the Seattle Center. After discussion with Mr. Jerry McGuire of Seattle Transit's schedule department, four existing transit routes were selected which could best be diverted to, and terminated at, the Seattle Center and still leave sufficient transit service in the area between Mercer Street and the north CBD area at Pine Street. The routes considered are trolley routes 1-13 and 2 from Queen Anne Hill and diesel bus routes 5 and 6-16 from Aurora Avenue North. Figure 40 illustrates the existing routing of the four lines just mentioned in the vicinity of the Seattle Center. Figure 41 shows how these routes might be altered so as to turn them around at the new Monorail terminal. Passenger transfer could then be made to the Monorail for the remaining ride into town. Passengers whose destinations lie between the Monorail terminals could transfer to one of the remaining routes serving the area between Mercer Street and Pine Street (see Figure 41).

The benefits of such a system are obvious, since it allows the elimination of four bus routes from the downtown area. From the passenger stand-point, any switch of transportation modes is generally undesirable. In this case, however, it is anticipated that nothing would be lost for the transit passenger and some time could even be gained. Assuming a maximum six minute wait for the monorail and then a two minute ride into town, a total maximum travel time of eight minutes (with a possible minimum of two minutes) is achieved from the Seattle Center to downtown. During the rush hours, and other periods of heavy traffic downtown, it is not uncommon for transit buses to travel the same route as the Monorail in more than eight minutes elapsed time. And with buses there is little or no chance of improving on that time due to congestion in the streets.

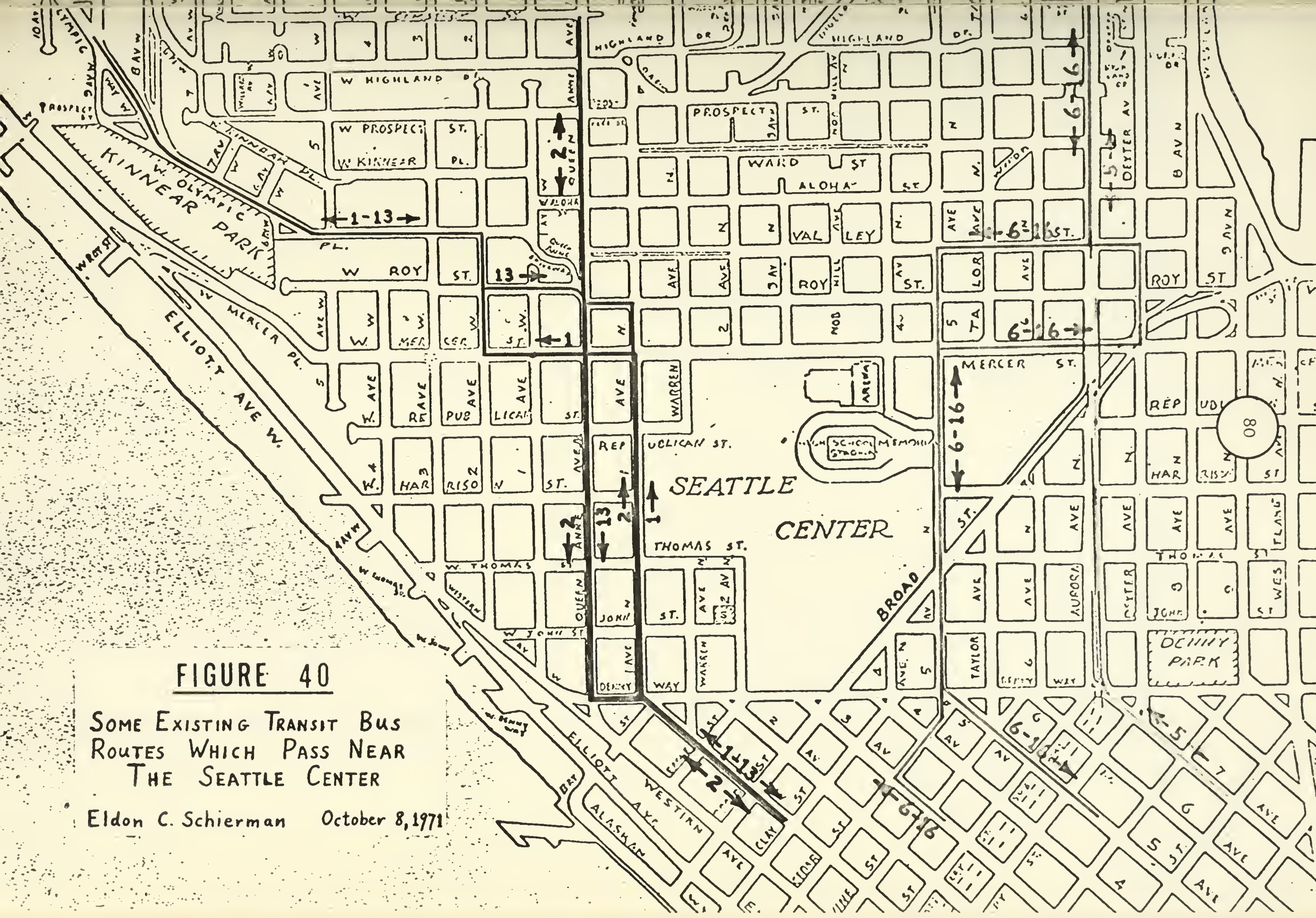


FIGURE 40

Some Existing Transit Bus Routes Which Pass Near The Seattle Center

Eldon C. Schierman October 8, 1971

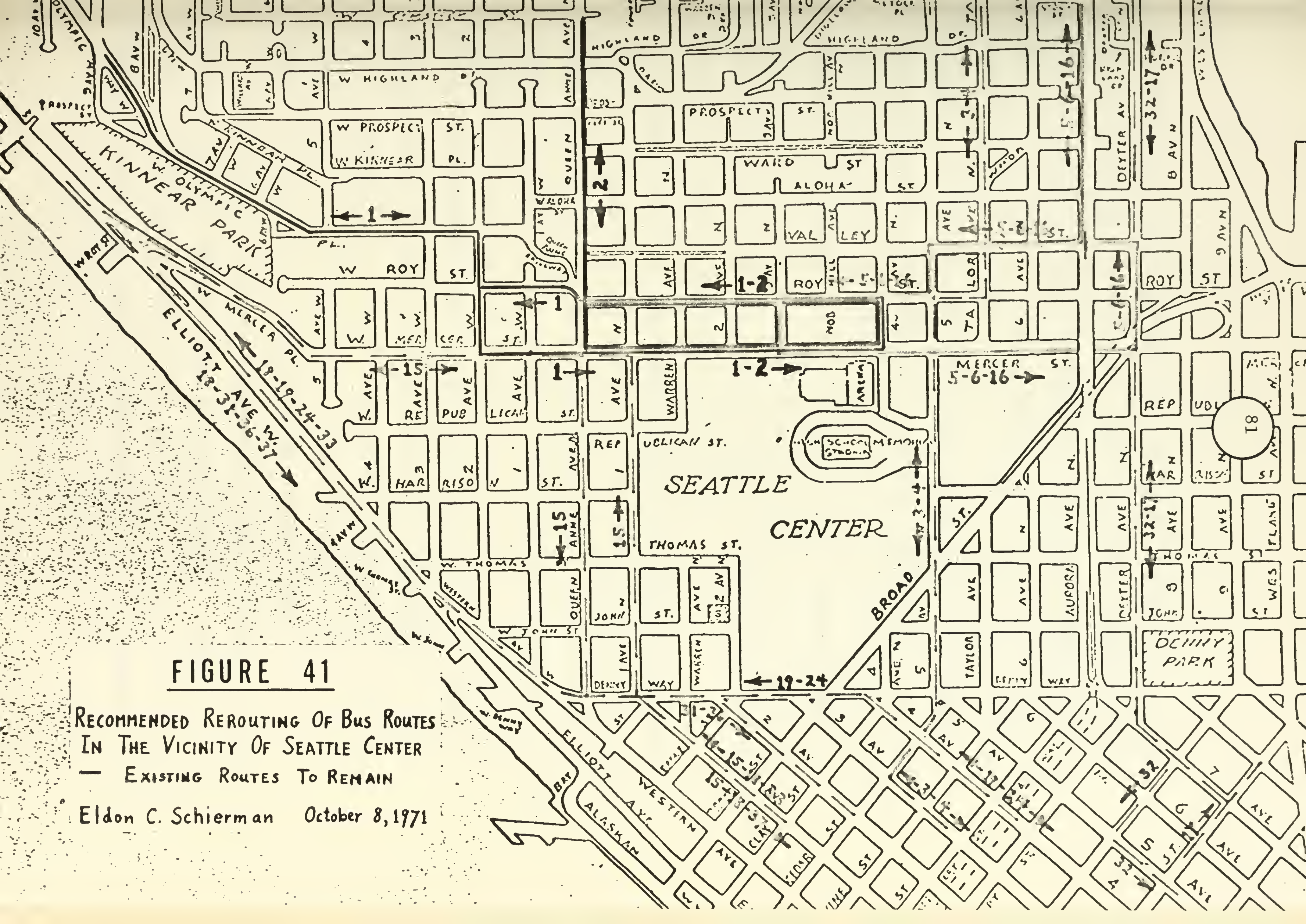


FIGURE 41

Recommended Rerouting Of Bus Routes
In The Vicinity Of Seattle Center
— Existing Routes To Remain

Eldon C. Schierman October 8, 1971

Quite conceivably, it might prove desirable to terminate the aforementioned bus routes at the Seattle Center Garage only during the 7:00 - 9:00 AM and 4:30 - 6:30 PM peak periods. During other periods of the day, the buses would operate as they presently are scheduled. The reasons for the switch during peak periods only is two-fold. First, the Monorail is operating at its maximum intensity during these periods, thus providing maximum passenger carrying capacity and minimum waiting times. Secondly, during these periods the street congestion downtown is at its worst, and the elimination of any buses would be of some benefit. During off-peak hours, the waiting time for the Monorail increases, thus increasing total travel time, whereas the travel time by bus through the downtown area decreases, because the traffic congestion is not as great.

Tables VII and VIII list the anticipated bus arrival and departure times at the Garage Monorail terminal and the estimated passenger accumulation for the four bus routes previously discussed. The farthest left column in each table lists the Monorail departure times during the A.M. peak period and the Monorail arrival times during the P.M. peak period. As can be seen from Table VII, the maximum accumulation during the AM peak is 194 passenger during the period from 7:36 to 7:42 AM. Reducing this total by 5%, or 9 passengers, to allow for individuals transferring to another bus route instead of the Monorail, an estimated 185 people remain who would transfer from the bus that they are riding to the Monorail.

From previous discussion it was estimated that 1300 potential Monorail passengers would be generated from the Parking Garage. Assuming that these 1300 arrive within a one hour period and the Monorail makes ten runs during that hour, the average demand is 130 passengers per run. Assuming a peaking

BUS ROUTES HAVING POTENTIAL FOR TERMINATION AT THE PARKING STRUCTURE
AM Peak Hours (7;00 - 9:00 am) - Passenger Accumulations

AM	Route 1-13 (1st&Den)				Route 2 (1st&Denny)				Route 5 (7th & Bell)				Route 6-16 (5th&Ced)				TOTAL	
Time Begin. At	Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		SB	NB
	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load		
7:00					7:01	42	7:05	6	7:03	52					7:00	11	94	11
7:06							7:10	1			7:07	13	7:08	35	7:05	4	35	18
7:12	7:16	53	7:12	10	7:13	51	7:15	10	7:13	44	7:16	2					148	22
7:18			7:18	4	7:23	55	7:22	4	7:21	42			7:22	40			137	8
7:24					7:29	42			7:26	23	7:26	1	7:26	50			115	1
7:30	7:30	41					7:33	7	7:33	49					7:31	48	90	55
7:36	7:40	48	7:37	8	7:36	56			7:41	45			7:41	45			194	8
7:42			7:45	3	7:43	43	7:42	6	7:46	50	7:43	10	7:45	60			153	19
7:48	7:51	39			7:49	52	7:52	13	7:53	48			7:47	34			173	13
7:54									7:58	35			7:56	18	7:54	46	53	46
8:00	8:05	13			8:00	58					8:01	3			8:03	10	71	13
8:06	8:06	19	8:10	5	8:08	58	8:06	17	8:06	56			8:10	50			183	22
8:12					8:14	48	8:14	5	8:11	47	8:13	8					95	13
8:18	8:19	44			8:21	15			8:23	28			8:18	55	8:22	8	142	8
8:24											8:29						0	12
8:30					8:32	57	8:32	33	8:34	39			8:32	36			132	33
8:36	8:41	50	8:40	11	8:41	15											65	11
8:42							8:45	10	8:43	21	8:42	8	8:43	50			71	18
8:48									8:49	48	8:52	7					48	7
8:54					8:57	32							8:58	22	8:56	14	54	14
																Total:	2053	362

TABLE VII

BUS ROUTES HAVING POTENTIAL FOR TERMINATION AT THE PARKING STRUCTURE
PM Peak Hours (4:00 - 6:00 pm) - Passenger Accumulations

PM	Route 1-13(1st&Den)				Route 2(1st&Denny)				Route 5(7th & Bell)				Route 6-16(5th&Ced)				TOTAL	
Time	Southbound		Northbound		Southbound		Northbound		Southbound		Northbound		Southbound		Northbound			
Begin. At	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	Arriv Time	Pass Load	SB	NB
4:00					4:01	30											30	0
4:06	4:08	18	4:11	47	4:11	19	4:06	32	4:07	25					4:09	22	62	101
4:12							4:14	12	4:16	24							24	12
4:18					4:20	31	4:23	44	4:22	20							51	44
4:24					4:29	13							4:25	18	4:24	26	31	26
4:30			4:34	24			4:33	24	4:35	50			~~4:35~~	~~50~~			50	48
4:36	4:38	5			4:38	16	4:41	42	4:38	30			4:40	18			69	42
4:42					4:46	24			4:46	44					4:44	66	68	66
4:48	~~5:00~~	~~10~~	4:53	50	4:53	10	4:50	57	4:52	38	Data Not Available				4:49	22	48	129
4:54							4:58	59					4:55	8			8	59
5:00	5:00	10			5:02	11	5:05	38	5:02	46							67	38
5:06			5:07	40					5:07	48			5:08	26	5:08	58	74	98
5:12			5:17	34	5:13	28	5:14	47	5:13	46			5:12	5	5:14	38	79	119
5:18	5:23	3			5:23	8	5:21	111	5:20	60					5:21	49	71	160
5:24			5:29	49					5:24	29					5:28	14	29	63
5:30	5:35	1	5:35	24	5:35	10	5:32	42	5:31	35							46	66
5:36							5:40	41	5:39	45			5:38	8			53	41
5:42			5:47	18	5:42	10	5:46	46	5:47	35					5:44	38	45	102
5:48	5:53	7			5:53	4											11	0
5:54	5:56	8			5:59	2	5:57	45							5:54	24	10	69
																Total:	926	1283

TABLE VIII

factor of 2 and multiplying this factor by 130 passengers per run, it is estimated that the maximum demand generated by the parkers would be 260 passengers per run. This figure, when added to the 184 transferring transit riders, results in a maximum Monorail demand during the AM peak period of 444 passengers per run. Such a passenger accumulation is within the capacity limits of the Monorail train (capacity - 450), however approximately two-thirds of the total would be required to stand, a situation deemed undesirable in view of modern transit standards.

It is considered unlikely that such a passenger demand would ever actually be achieved during normal week-day operation. Table VII reveals that the greatest bus transit accumulation occurs during the period from 7:00 AM to 8:00 AM and then begins to taper off significantly after 8:00 AM. This probably is due to the fact that workers commuting by bus are generally lower payed blue collar or office staff workers whose work day begins at 8:00 AM. Commuters who travel by car are generally of the higher incomed business, executive, or professional nature. Their work days generally commence in the period from 8:00 AM to 9:00 AM. Thus, it is estimated that the peak accumulation of these two types of commuter will not coincide, and that the maximum levels of train loading would remain at a more acceptable level of about 300 passengers per run. During the 7:00 AM to 9:00 AM, 2 hour A.M. peak period, 2053 bus passengers plus 1300 parkers for a total of 3353 people would ride the Monorail. Rounding to 3400 passengers and then dividing this figure by 20 train runs per peak 2-hr. period, an average of 170 passengers per run is estimated. This average makes the estimated maximum accumulation of 300 passengers per run during peak periods look quite reasonable.

As can be seen from the preceding discussion, passenger standing on the Monorail would be experienced during peak period operation. The passenger average of 170 exceeds the train seating capacity by 46. During maximum passenger accumulation, it is anticipated that the Monorail may have as many as 175 standees. However, since the duration of the Monorail run is so short (approximately 2 minutes), it is hoped that required standing will not significantly detract from the system's attraction.

CHAPTER VI

CONCLUSION

In this chapter discussion is presented covering several topics which were left dangling in previous chapters. Included is further comparison of Seattle Transit's "park-and'ride" commuter parking lot with the proposed Monorail and Seattle Center Garage system. Also discussed are the affects of possible Federal capital grants, varying rates of interest, and periods of bond maturity on the benefit-cost ratio of the proposed. Brief coverage is given to the topic of Federal funding and the availability of money to help finance the proposed project. Finally, recommendations are suggested for further topics of investigation.

COMPARISON OF THE PROPOSAL WITH SEATTLE TRANSIT'S "PARK-AND-RIDE" SYSTEM

Detailed discussion of the mechanics of operation of Seattle Transit's "park-and'ride" parking system is given in Chapter II. Also presented is evidence that Seattle commuters are not yet ready to actively patronize such an operation, for, in fact, the lot has only experienced about one-third capacity usage in recent years. Response to questions contained in the Monorail Study Survey questionnaire reveals that of those commuters who are aware of Seattle Transit's operation, nine out of ten favor their downtown parking arrangements to the point of never having even tried Transit's lot at the Seattle Center. The remaining 10% of the commuters indicate that they have tried the system and rejected it in favor of downtown parking. Several of the respondents expressed comments on their questionnaires which may help to explain the generally low degree of patronage.

1. The Seattle Transit commuter parking lot is unattended and exposed to the open air. This fact subjects commuter vehicles to the work of vandals as well as the weather.
2. Transit connection at the lot is with regular transit routes along 5th Avenue. The bus stop is open to the weather. During peak hours along that corridor, transit averages about six minutes between buses. The ride downtown averages about seven minutes in heavy traffic and has frequent stops. As a result a person parking his car at Transit's Seattle Center lot can expect to spend 10 to 15 additional minutes (not including the walk from a downtown bus stop to place of employment) traveling via an already over-crowded bus making frequent stops enroute downtown.
3. Finally, Seattle Transit has not attempted to advertise their lot in recent years. A properly conducted advertising campaign could result in more use of their lot.

The proposed system which employs an extended Monorail and, also, the Seattle Center Parking Garage offers covered, attended parking for commuter customers, thus satisfying the first objection. Secondly, an average of only five minutes (three waiting at the station and two on the train) is required to travel from the garage to the downtown area. Also, the ride is non-stop in a clean, quiet, modern, relatively spacious vehicle. Finally, it is expected that the uniqueness and glamour of the Monorail, along with its direct association with the Seattle Center, will generate enough publicity to sustain the proposed system once it goes into operation.

ANALYSIS OF FINANCING ALTERNATIVES

It is evident to anyone familiar with accounting and interest rates that the annual cost of a public works project (or any capitalized project for that matter) is, among other things, a function of bond interest rate and the duration of the bond to maturity. In Chapter IV calculation of a B/C ratio is presented which is based on an assumed bond interest rate of 6% per year (compounded annually) and a maturity period of 30 years. Table IX illustrates the effect of varying interest by 1% increments from 6% to 8% annually for 20 year, 25 year, and 30 year periods. A third variable which is introduced is the effect of Federal aid covering the capital costs of the proposed system up to a maximum two-thirds of the total construction costs. From the table it can be seen that given the most favorable conditions of bonding (i.e., 6% interest for a 30 year period), $333,000.00 or 34.9% of the total capital investment is needed from outside sources in order to achieve a B/C ratio of exactly 1.00. If two-thirds Federal funding is achieved, the B/C ratio is a favorable 1.128. If the bonding situation is at its worst (i.e., 8% interest for a 20 year period), then $511,000.00 of Federal funds are required in order to break even. Under these conditions, a two-thirds capital grant will result in a B/C ratio of 1.070. In summary, it is concluded that a Federal grant of between $333,000 to $511,000 (depending on local bond interest rates and duration of bonding) is required in order to make the proposed Monorail extension and Seattle Center Parking Garage system economically feasible.

TABLE IX

BENEFIT-COST RATIOS FOR VARIOUS INTEREST RATES, LENGTHS OF BONDING, AND AMOUNTS OF FEDERAL AID

Annual Interest Rate	Annual Costs (No Federal Funding)	B/C Ratio	Amt. of Fed. Financ. Reqd. To Achieve A B/C = 1.00	% Of Total Capital Cost	An. Cost With Max. Avail. Fed. Financ. (2/3 Cap Cost)	Result B/C Ratio
20-Year Bonding Period:						
6 %	$ 232,757.00	0.836	$ 437,500.00	45.8%	$ 177,252.00	1.098
7 %	$ 239,642.00	0.813	$ 476,000.00	49.9%	$ 179,547.00	1.083
8 %	$ 246,767.00	0.788	$ 511,000.00	53.5%	$ 181,922.00	1.070
25-Year Bonding Period:						
6 %	$ 224,210.00	0.868	$ 378,000.00	39.6%	$ 174,403.00	1.116
7 %	$ 231,449.00	0.841	$ 429,000.00	44.9%	$ 177,816.00	1.101
8 %	$ 238,964.00	0.814	$ 473,000.00	49.6%	$ 179,319.00	1.085
30-Year Bonding Period:						
6 %	$ 218,880.00	0.889	$ 333,000.00	34.9%	$ 172,624.00	1.128
7 %	$ 226,463.00	0.859	$ 395,000.00	41.3%	$ 175,154.00	1.111
8 %	$ 234,333.00	0.830	$ 446,000.00	46.7%	$ 178,777.00	1.090

THE AVAILABILITY OF FEDERAL ASSISTANCE

Federal grants for a project such as the one proposed in this report could be made under any one of several programs being administered by one of several agencies of the federal government. Any application for aid by a local agency or governing body must be submitted to the Northwest Federal Regional Council. This Council is made up of representatives from the departments of Health, Education and Welfare (HEW); Housing and Urban Development (HUD); Manpower Administration, Department of Labor (DOL); Office of Economic Opportunity (OEO); and Department of Transportation (DOT). The Northwest Council administers programs in the states of Alaska, Idaho, Oregon, and Washington. Applications for federal aid are considered by this body and channeled to the most favorable program in any one of the five federal departments.

It is the opinion of this author that the Urban Mass Transportation Administration of the Department of Transportation offers the best opportunity for federal aid to a program such as the one proposed. UMTA administers the Urban Mass Transportation Act of 1964, as amended, which provides significant funds for maintaining and improving public transit systems in urban areas. It is believed that a grant of up to two-thirds of the capital cost of the project (or $636,667.00) can be justified under the "Demonstration and Research Grant" provisions of the Act. With the granting of $636,667.00 in federal aid, the Monorail extension proposal to provide fringe area daytime parking for the north Seattle downtown area proves to be economically feasible. It is, therefore, strongly recommended by this author that the proposal as outlined in this report be seriously considered for implementation.

REFLECTIONS AND RECOMMENDATIONS

It is recognized by this author that several topics of interest which relate to the subject at hand are not fully covered in this investigation. Along this line, the economic impact of a City owned and operated system on the operators of existing parking systems in the downtown area is a subject that requires further detailed investigation. The realm of this topic is quite extensive, for it entails a prediction of future levels of business activity in the central business district. Commercial operators recognize that their money is made by maximizing usage of garage spaces by short term parkers. The rates per hour for short term parking are generally much higher than for long term parkers who pay by the month. Monthly parking is generally sold at a small loss, or at best at break-even, so as to minimize the loss resulting from spaces that might otherwise go unused. During periods of brisk commercial activity in downtown Seattle, garage operators will attempt to make as many spaces as possible available for the short term, high turnover, high profit type of parking. The impact of removing 1000 long term, monthly parkers from the downtown area would probably be minimal. However, during periods of economic slowdown or recession when short term parkers are scarce, competition among operators for the remaining monthly parkers is keen and removal of 1000 potential customers would probably greatly affect their business. In reality, the economy cycles between periods of recession and periods of prosperity. An economic analysis of downtown Seattle and the Seattle metropolitan area as a whole would be necessary in order to estimate the frequency of the cycles and the magnitude of the peaks and valleys. From this, future long term and short term demand is predicted as well as the estimated impact of the Monorail system during future periods of time.

The economic analysis of the proposed system as presented in this paper is simplified to the point that only the dollar costs and income benefits of the system are included. Other, more subjective factors, such as user savings in terms of time, overall commuting costs, etc., are not taken into account. In the downtown survey conducted by this author, the first question is worded such that the responding person must subjectively weigh all of the factors involved, such as time, cost, convenience, etc., before answering the question. In this respect it matters little that the user actually realizes a measurable savings or benefit from the system but only that he believes he is realizing a benefit when compared to other perceived alternatives.

On the other hand, there are some areas of the economic investigation of the proposal that still require additional detailed effort. These include:

A. An analysis of the monetary savings realized by Seattle Transit system by termination of the recommended bus routes at the Seattle Center Garage.

B. Analysis of the effect of the Monorail proposal on Transit's "park-and-ride" operation. How much money would be lost to Transit as a result of decreased lot usage, and how does this compare to the increased incomes available to Transit as a result of more intensified Monorail usage?

C. What is the degree of impact on traffic congestion in the downtown area when 1000 commuting vehicles are induced to park on the fringe at the Seattle Center? Is this benefit significant, or even measurable?

In summary, it is recommended that the topics mentioned in this section, as well as those previously discussed in the body of this report, be considered for further investigation. Additional investigation will allow refinement of the economic analysis of the system as well as give a basis for determining the social and community impacts of the proposal. No expenditure of public funds should be authorized without also taking these factors into account.

APPENDIX A

Figures A-1, A-2, and A-3 are copies of the three questionnaires used by Victor O. Gray and Company, Consulting Engineers of Seattle, Washington, in their 1970 survey of long-term parking characteristics of employees in the Seattle downtown area. Survey # 1 (Figure A-1) was the initial survey effort, covering the central heart of the CBD. Questionnaires for surveys # 2 and # 3 (Figures A-2 and A-3) are revisions of that used for the first survey. They differ from each other only in the portion of the CBD (northern or southern) which is shown in the access diagram. Figures A-2 (b) and A-3 (b) are access diagram keys associated with Figures A-2 and A-3 respectively.

Surveys # 1 and # 3 are of particular interest, as they cover those blocks contained in this study's designated downtown area of analysis. Table A-1 through A-III detail the applicable data.

CITY OF SEATTLE

SEATTLE PARKING COMMISSION

Citizens of Downtown
Seattle, Washington

Re: Parking Survey Questionnaire

Ladies and Gentlemen:

The Seattle City Council recently established the Seattle Parking Commission to help solve the parking problems throughout the entire city. We are seeking your cooperation in assisting us to accomplish our goals. The initial step of the Parking Commission has been to authorize a study of the parking needs for the entire downtown area.

We would appreciate it very much if you would take the time to fill out this questionnaire, as soon as possible, and return it to your employer, or your office manager. The questionnaire will be collected and the information carefully reviewed by the Commission in its deliberations regarding future parking programs.

Your signature and home address are *not* required as a part of this survey. Thank you for your cooperation.

Sincerely,

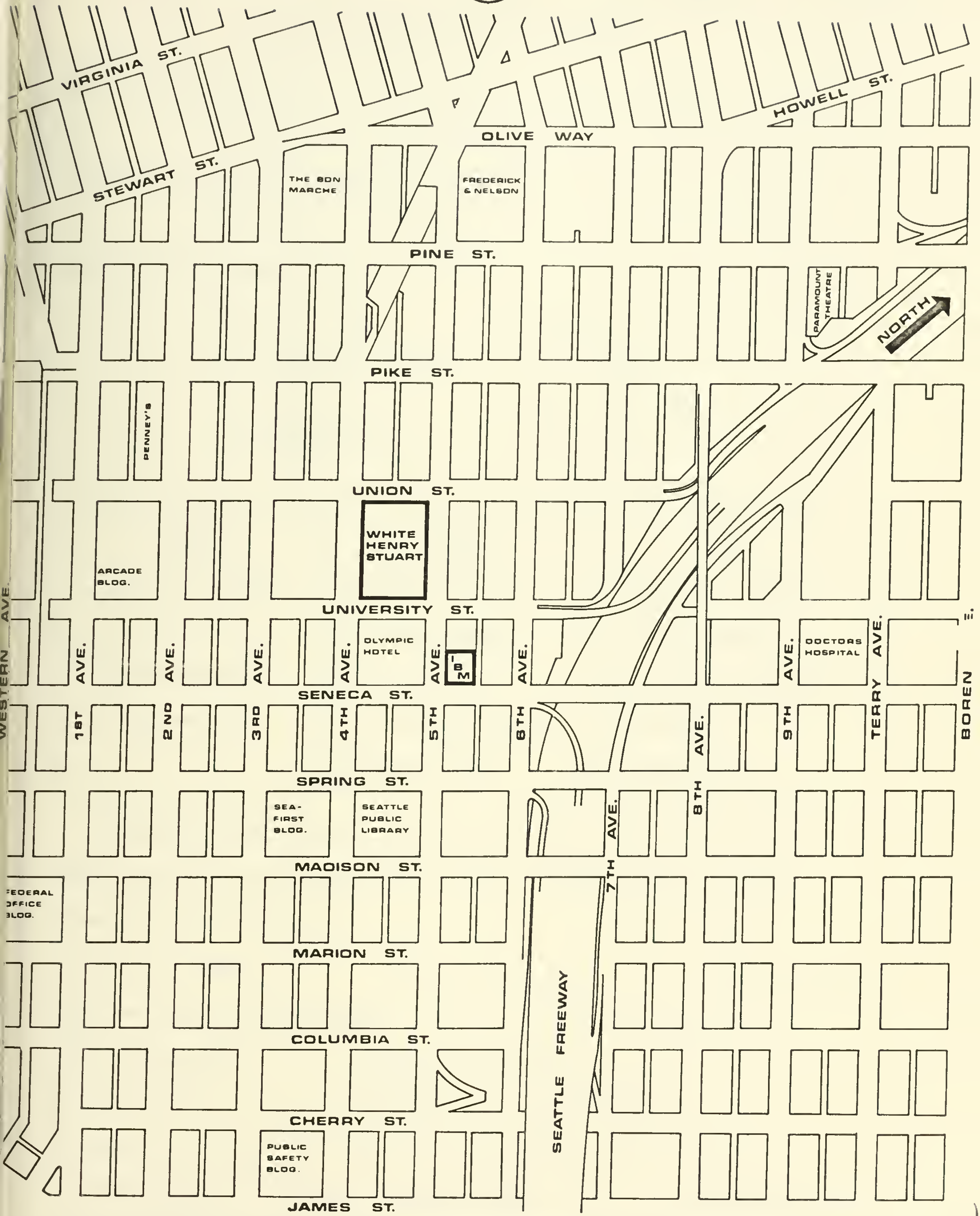
SEATTLE PARKING COMMISSION

Anthony Eyring, Chairman
Donald A. Lockwood
Harry G. Livingston
Everett W. Nordstrom
Ray Olsen

VICTOR O. GRAY and COMPANY'S
DOWNTOWN COMPREHENSIVE PARKING STUDY

SURVEY # 1 - QUESTIONNAIRE

FIGURE A-1


VIRGINIA ST.
STEWART ST.
OLIVE WAY
HOWELL ST.
THE BON MARCHE
FREDERICK & NELSON
PINE ST.
PARAMOUNT THEATRE
NORTH
PIKE ST.
PENNEY'S
UNION ST.
WHITE HENRY STUART
ARCADE BLDG.
UNIVERSITY ST.
OLYMPIC HOTEL
I B M
DOCTORS HOSPITAL
WESTERN AVE.
1ST AVE.
2ND AVE.
3RD AVE.
4TH AVE.
5TH AVE.
6TH AVE.
7TH AVE.
8TH AVE.
9TH AVE.
TERRY AVE.
BOREN AVE.
SENECA ST.
SPRING ST.
SEA-FIRST BLDG.
SEATTLE PUBLIC LIBRARY
MADISON ST.
FEDERAL OFFICE BLDG.
MARION ST.
COLUMBIA ST.
SEATTLE FREEWAY
CHERRY ST.
PUBLIC SAFETY BLDG.
JAMES ST.

PARKING SURVEY QUESTIONNAIRE FORM – DOWNTOWN WORKERS

Please check appropriate box for each question.

1. What is your *home* zip code? (1) Zip Code ____________

2. Sex (1) ☐ Male (2) ☐ Female

3. Do you have an automobile available to drive to work?

   (1) ☐ Yes (2) ☐ No

4. How did you arrive at work today?

   (1) ☐ Drove vehicle
   (2) ☐ Passenger in auto that parked downtown
   (3) ☐ Dropped off. Car did not park.
   (4) ☐ Bus
   (5) ☐ Walked
   (6) ☐ Taxi or other
   (7) ☐ Ferry

5. If *you drove* to work, by which of the following routes did you come to the *Downtown Area?*

SOUTH	NORTH	EAST
☐ I-5 from the South	☐ I-5 from the North	☐ Yesler Way; James St.
☐ 1st Ave. South	☐ Fairview; Westlake	☐ Pine St.; Pike St.
☐ 4th Ave. South	☐ Aurora; Dexter	☐ E. Madison St.; Seneca St.
☐ Alaskan Way	☐ Queen Anne; 5th Ave. No.	☐ Olive Way
	☐ Elliott Ave. West	☐ Dearborn St.

☐ Other Route. Please name ____________

6. Using the map on the opposite page, mark "X" in the block or facility where you parked.

7. In what type of space did you park?

   (1) ☐ Public off-street (2) ☐ Private facility (3) ☐ Curb space

8. About how long do you park each day?

   (1) ☐ 4 hours or less (2) ☐ 4 hours or more

9. Do you pay to park? (1) ☐ Yes (2) ☐ No

10. Do you park

   (1) ☐ By the hour? (2) ☐ By the day? (3) ☐ By the month?

11. Do you have any suggestions on how to help solve our parking problem? Please comment in space provided on next page.

MENTS:

CENTRAL BUSINESS DISTRICT PARKING STUDY

Form Prepared By
VICTOR O. GRAY & COMPANY, INC.
CONSULTING ENGINEERS
224 – 1411 4th Ave. Building
Seattle, Washington 98101

3673

THE CITY OF SEATTLE WES UHLMAN, MAYOR

PARKING COMMISSION

MECHLIN D. MOORE, SECRETARY

1318 Joseph Vance Building • Seattle, Washington 98101

PARKING COMMISSION

ANTHONY I. EYRING, CHAIRMAN
HARRY G. LIVINGSTONE
DONALD A. LOCKWOOD
EVERETT W. NORDSTROM
RAY OLSEN

SEATTLE PARKING COMMISSION

Citizens of Downtown
Seattle, Washington

Re: Parking and Traffic Access Survey

Ladies and Gentlemen:

The Seattle City Council recently established the Seattle Parking Commission to help solve the parking problems throughout the entire city. We are seeking your cooperation in assisting us to accomplish our goals. The initial step of the Parking Commission has been to authorize a study of the parking needs for the entire downtown area.

We would appreciate it very much if you would take the time to fill out this questionnaire, as soon as possible, and return it to your employer, or your office manager. The questionnaire will be collected and the information carefully reviewed by the Commission in its deliberations regarding future parking programs.

Questions 1 through 11 will provide information for the Seattle Parking Commission, whereas questions 12 through 16 are related to the Center Cities Transportation Study. The Center Cities Transportation Study, financed by the U.S. Department of Transportation, is seeking ways to improve circulation within the Central Business District.

Your signature and home address are *not* required as a part of this survey. Thank you for your cooperation.

Sincerely,

SEATTLE PARKING COMMISSION

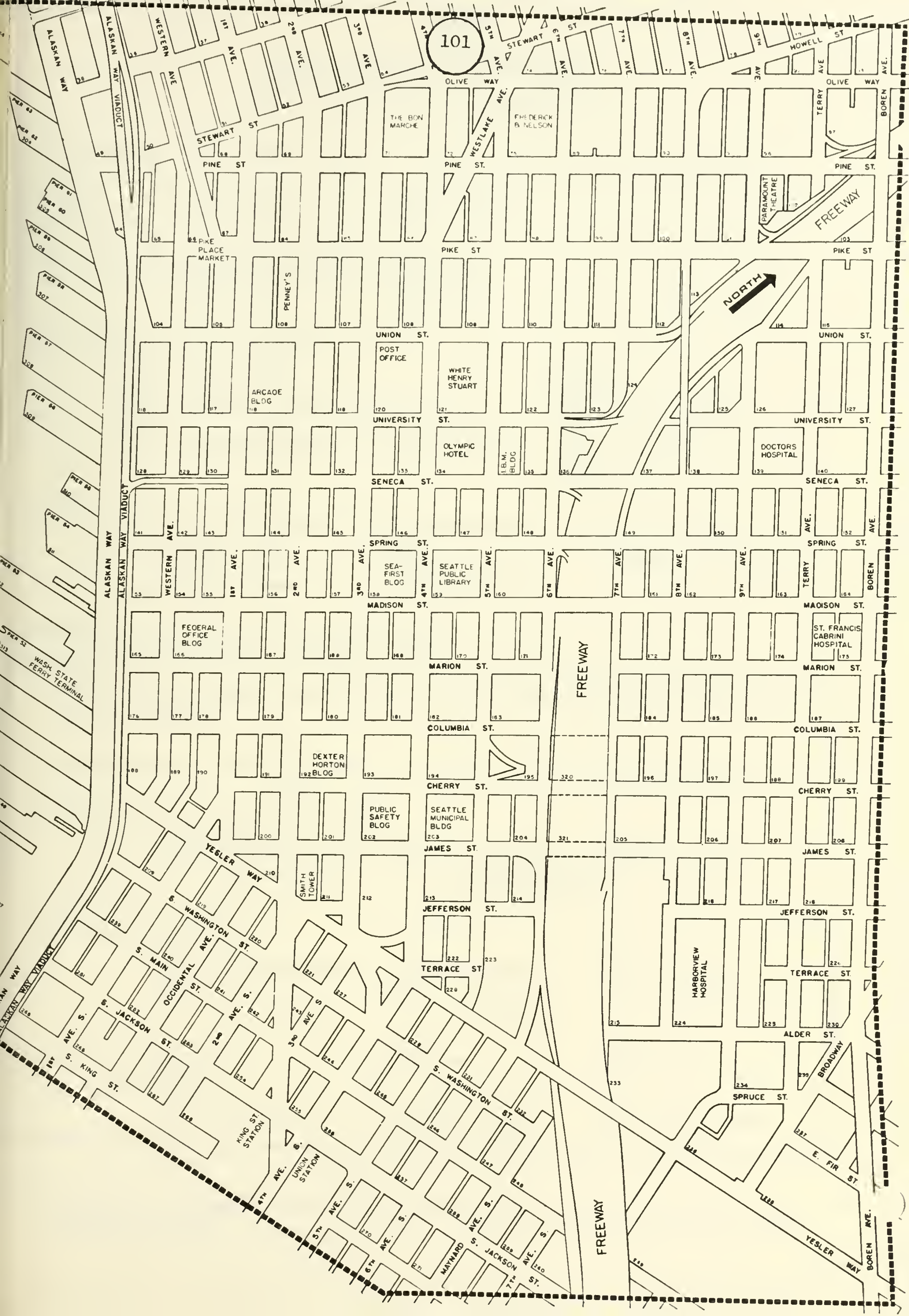
Anthony I. Eyring

Anthony I. Eyring, Chairman
Donald A. Lockwood
Harry G. Livingston
Everett W. Nordstrom
Ray Olsen

VICTOR O. GRAY and COMPANY'S
DOWNTOWN COMPREHENSIVE PARKING STUDY

SURVEY # 2 - QUESTIONNAIRE

FIGURE A-2(a)


101
ALASKAN WAY
ALASKAN WAY VIADUCT
WESTERN AVE.
1ST AVE.
2ND AVE.
3RD AVE.
4TH AVE.
5TH AVE.
6TH AVE.
7TH AVE.
8TH AVE.
9TH AVE.
TERRY AVE.
BOREN AVE.
STEWART ST
HOWELL ST
OLIVE WAY
WESTLAKE AVE.
THE BON MARCHE
FREDERICK & NELSON
PINE ST
PARAMOUNT THEATRE
FREEWAY
PIKE PLACE MARKET
PIKE ST
PENNEY'S
NORTH
UNION ST.
POST OFFICE
WHITE HENRY STUART
ARCADE BLDG
UNIVERSITY ST.
OLYMPIC HOTEL
I.B.M. BLDG
DOCTORS HOSPITAL
SENECA ST.
SPRING ST.
SEA-FIRST BLDG
SEATTLE PUBLIC LIBRARY
MADISON ST.
FEDERAL OFFICE BLDG
ST. FRANCIS CABRINI HOSPITAL
MARION ST.
COLUMBIA ST.
DEXTER HORTON BLDG
CHERRY ST.
PUBLIC SAFETY BLDG
SEATTLE MUNICIPAL BLDG
JAMES ST.
YESLER WAY
SMITH TOWER
JEFFERSON ST.
TERRACE ST
HARBORVIEW HOSPITAL
ALDER ST.
BROADWAY
SPRUCE ST.
E. FIR ST.
S. WASHINGTON ST.
S. MAIN ST.
OCCIDENTAL AVE. S.
2ND AVE. S.
3RD AVE. S.
S. JACKSON ST.
S. KING ST.
1ST AVE. S.
KING ST. STATION
UNION STATION
4TH AVE. S.
5TH AVE. S.
6TH AVE. S.
MAYNARD AVE. S.
7TH AVE. S.
WASH. STATE FERRY TERMINAL

PARKING AND TRAFFIC ACCESS SURVEY

Please check appropriate box for each question.

1. What is your *home* zip code? (1) Zip Code ____________________

2. Sex ☐ (1) Male ☐ (2) Female

3. Do you have an automobile available to drive to work?
   ☐ (1) Yes ☐ (2) No

4. How did *you* arrive at work *today?*
   ☐ (1) Drove vehicle
   ☐ (2) Passenger in auto that parked downtown
   ☐ (3) Dropped off; vehicle did not park downtown
   ☐ (4) Bus
   ☐ (5) Walked from home
   ☐ (6) Taxi or other
   ☐ (7) Ferry

5. If *you* arrived at work *today* by *auto,* how many people were in the vehicle? (Count yourself as 1.)
   ☐ (1) 1 person
   ☐ (2) 2 persons
   ☐ (3) 3 persons
   ☐ (4) 4 persons
   ☐ (5) 5 persons or more

DRIVERS ONLY — Please answer questions 6 through 10.

6. Using the map on the opposite page, place a (√) check mark at the location where you *first* drove across the dotted line.

7. Using the map on the opposite page, mark "X" in the block or facility where *you* parked *today.*

8. In what type of space did *you* park *today?*
   ☐ (1) Off-street facility for public usage
   ☐ (2) Off-street space provided by employer
   ☐ (3) Curb space

9. How long did *you* park *today?*
   ☐ (1) Less than 2 hours
   ☐ (2) 2 to 4 hours
   ☐ (3) 4 to 6 hours
   ☐ (4) 6 to 8 hours
   ☐ (5) More than 8 hours

10. A. Do you pay to park? ☐ (1) Yes ☐ (2) No

    B. If *yes,* do you pay
    ☐ (1) By the hour? ☐ (2) By the day? ☐ (3) By the month?

11. Do you have any suggestions on how to help solve our parking problem? Please comment in space provided on next page.

MENTS:

cluding yourself, how many persons are in your household? (1) ____________

ltogether, how many persons in your household are employed?

☐ (1) Yourself ☐ (2) Other household members

besides yourself, how many other members of your family work *downtown?*
(ay between I-5, Yesler, Denny Way and Waterfront.)

(1) ____________________

lease check the category below which includes your present age:

☐ (1) Under 21
☐ (2) 21 to 30
☐ (3) 31 to 40
☐ (4) 41 to 50
☐ (5) 51 to 65
☐ (6) Over 65

lease check the category below which represents the total income of your family last year before taxes.

☐ (1) $3,000 or less
☐ (2) Over $3,000 to $6,000
☐ (3) Over $6,000 to $9,000
☐ (4) Over $9,000 to $12,000
☐ (5) Over $12,000 to $15,000
☐ (6) Over $15,000 to $20,000
☐ (7) Over $20,000

CENTRAL BUSINESS DISTRICT PARKING STUDY

Form Prepared By
VICTOR O. GRAY & COMPANY, INC.
CONSULTING ENGINEERS
224 – 1411 4th Ave. Building
Seattle, Washington 98101

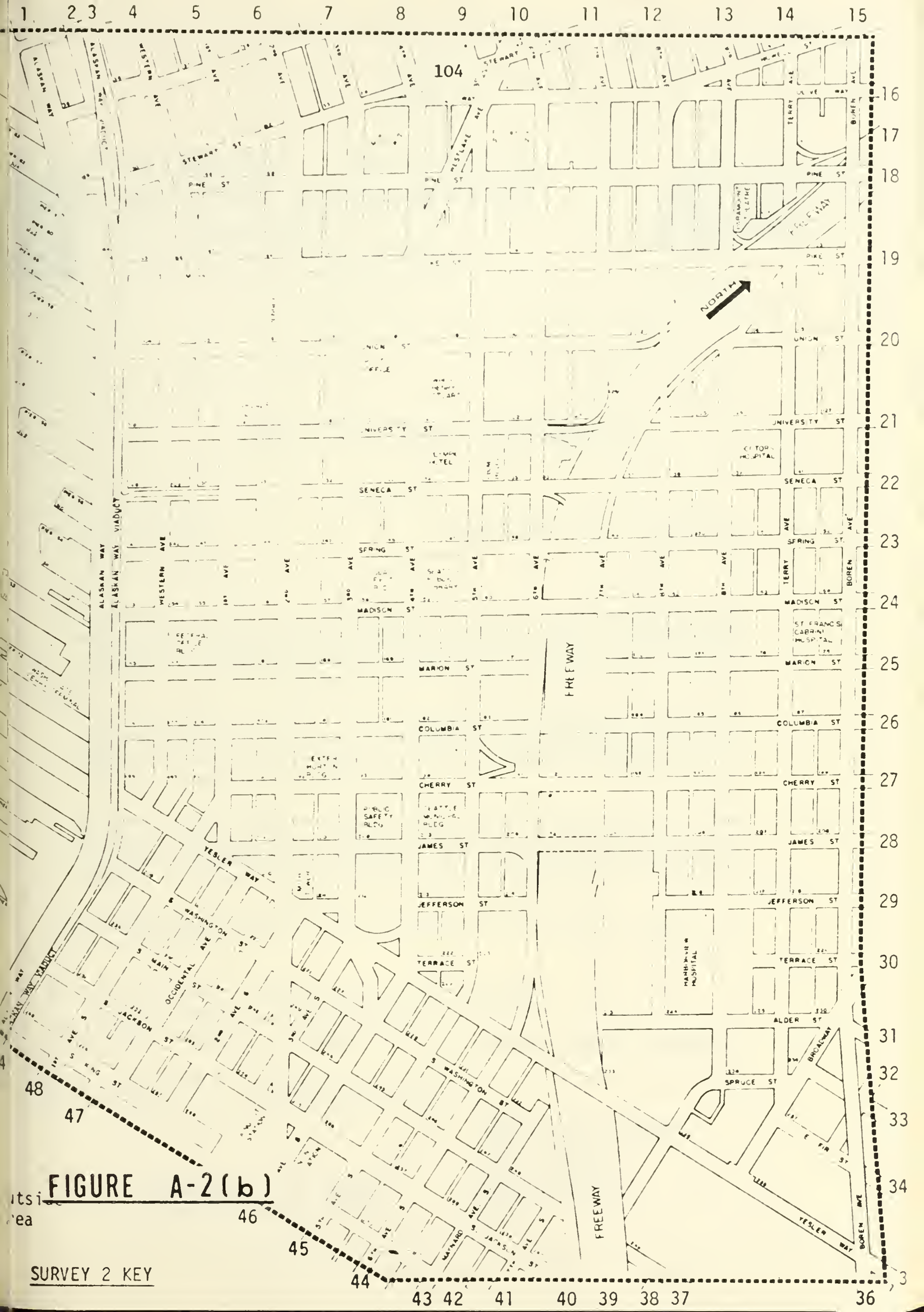


FIGURE A-2(b)

SURVEY 2 KEY

THE CITY OF SEATTLE WES UHLMAN, MAYOR
PARKING COMMISSION
MECHLIN D. MOORE, SECRETARY
1318 Joseph Vance Building • Seattle, Washington 98101

PARKING COMMISSION
ANTHONY I. EYRING, CHAIRMAN
HARRY G. LIVINGSTONE
DONALD A. LOCKWOOD
EVERETT W. NORDSTROM
RAY OLSEN

SEATTLE PARKING COMMISSION

Citizens of Downtown
Seattle, Washington

Re: Parking and Traffic Access Survey

Ladies and Gentlemen:

The Seattle City Council recently established the Seattle Parking Commission to help solve the parking problems throughout the entire city. We are seeking your cooperation in assisting us to accomplish our goals. The initial step of the Parking Commission has been to authorize a study of the parking needs for the entire downtown area.

We would appreciate it very much if you would take the time to fill out this questionnaire, as soon as possible, and return it to your employer, or your office manager. The questionnaire will be collected and the information carefully reviewed by the Commission in its deliberations regarding future parking programs.

Questions 1 through 11 will provide information for the Seattle Parking Commission, whereas questions 12 through 16 are related to the Center Cities Transportation Study. The Center Cities Transportation Study, financed by the U.S. Department of Transportation, is seeking ways to improve circulation within the Central Business District.

Your signature and home address are *not* required as a part of this survey. Thank you for your cooperation.

VICTOR O. GRAY and COMPANY'S
DOWNTOWN COMPREHENSIVE PARKING STUDY

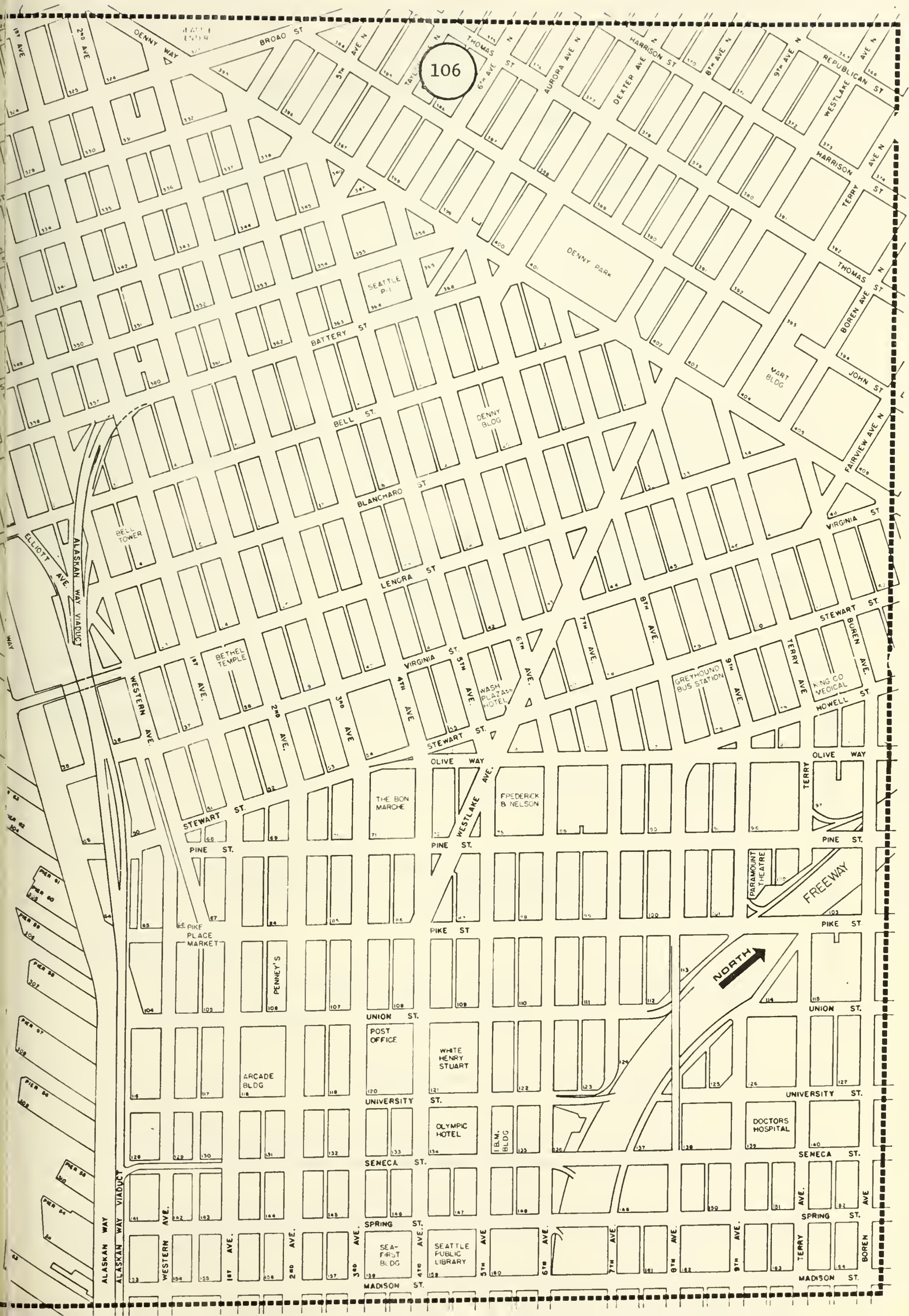
SURVEY # 3 – QUESTIONNAIRE

Sincerely,

SEATTLE PARKING COMMISSION

Anthony I. Eyring, Chairman
Donald A. Lockwood
Harry G. Livingston
Everett W. Nordstrom
Ray Olsen

FIGURE A-3(a)


DENNY WAY
BROAD ST
5TH AVE N
6TH AVE
THOMAS ST
AURORA AVE N
DEXTER AVE N
HARRISON ST
8TH AVE N
9TH AVE N
REPUBLICAN ST
WESTLAKE AVE
TERRY AVE N
HARRISON ST
DENNY PARK
THOMAS ST
BOREN AVE
SEATTLE P-I
BATTERY ST
MART BLDG
JOHN ST
FAIRVIEW AVE N
BELL ST
DENNY BLDG
BLANCHARD ST
VIRGINIA ST
BELL TOWER
ELLIOTT AVE
ALASKAN WAY VIADUCT
LENORA ST
STEWART ST
BOREN AVE
BETHEL TEMPLE
1ST AVE
2ND AVE
3RD AVE
4TH AVE
5TH AVE
6TH AVE
7TH AVE
8TH AVE
9TH AVE
VIRGINIA ST
WESTERN AVE
WASH PLAZA HOTEL
GREYHOUND BUS STATION
TERRY AVE
KING CO MEDICAL
HOWELL ST
STEWART ST
OLIVE WAY
THE BON MARCHE
WESTLAKE AVE
FREDERICK & NELSON
STEWART ST
PINE ST
PARAMOUNT THEATRE
FREEWAY
PIKE PLACE MARKET
PIKE ST
NORTH
PENNEY'S
UNION ST
POST OFFICE
WHITE HENRY STUART
ARCADE BLDG
UNIVERSITY ST
OLYMPIC HOTEL
I.B.M. BLDG
DOCTORS HOSPITAL
SENECA ST
SPRING ST
SEA-FIRST BLDG
SEATTLE PUBLIC LIBRARY
BOREN
MADISON ST
ALASKAN WAY
ALASKAN WAY VIADUCT
WESTERN AVE

PARKING AND TRAFFIC ACCESS SURVEY

Please check appropriate box for each question.

1. What is your *home* zip code? (1) Zip Code ______________

2. Sex ☐ (1) Male ☐ (2) Female

3. Do you have an automobile available to drive to work?
   ☐ (1) Yes ☐ (2) No

4. How did *you* arrive at work *today?*
   ☐ (1) Drove vehicle
   ☐ (2) Passenger in auto that parked downtown
   ☐ (3) Dropped off; vehicle did not park downtown
   ☐ (4) Bus
   ☐ (5) Walked from home
   ☐ (6) Taxi or other
   ☐ (7) Ferry

5. If *you* arrived at work *today* by *auto,* how many people were in the vehicle? (Count yourself as 1.)
   ☐ (1) 1 person
   ☐ (2) 2 persons
   ☐ (3) 3 persons
   ☐ (4) 4 persons
   ☐ (5) 5 persons or more

DRIVERS ONLY — Please answer questions 6 through 10.

6. Using the map on the opposite page, place a (✓) check mark at the location where you *first* drove across the dotted line.

7. Using the map on the opposite page, mark "X" in the block or facility where *you* parked *today.*

8. In what type of space did *you* park *today?*
   ☐ (1) Off-street facility for public usage
   ☐ (2) Off-street space provided by employer
   ☐ (3) Curb space

9. How long did *you* park *today?*
   ☐ (1) Less than 2 hours
   ☐ (2) 2 to 4 hours
   ☐ (3) 4 to 6 hours
   ☐ (4) 6 to 8 hours
   ☐ (5) More than 8 hours

10. A. Do you pay to park? ☐ (1) Yes ☐ (2) No

    B. If *yes,* do you pay
    ☐ (1) By the hour? ☐ (2) By the day? ☐ (3) By the month?

11. Do you have any suggestions on how to help solve our parking problem? Please comment in space provided on next page.

NTS:

luding yourself, how many persons are in your household? (1) ______________

ogether, how many persons in your household are employed?

☐ (1) Yourself ☐ (2) Other household members

ides yourself, how many other members of your family work *downtown?*
y between I-5, Yesler, Denny Way and Waterfront.)

(1) ______________

ase check the category below which includes your present age:

☐ (1) Under 21
☐ (2) 21 to 30
☐ (3) 31 to 40
☐ (4) 41 to 50
☐ (5) 51 to 65
☐ (6) Over 65

ase check the category below which represents the total income of your family last year before taxes.

☐ (1) $3,000 or less
☐ (2) Over $3,000 to $6,000
☐ (3) Over $6,000 to $9,000
☐ (4) Over $9,000 to $12,000
☐ (5) Over $12,000 to $15,000
☐ (6) Over $15,000 to $20,000
☐ (7) Over $20,000

CENTRAL BUSINESS DISTRICT PARKING STUDY

Form Prepared By
VICTOR O. GRAY & COMPANY, INC.
CONSULTING ENGINEERS
224 – 1411 4th Ave. Building
Seattle, Washington 98101

SURVEY 3 KEY

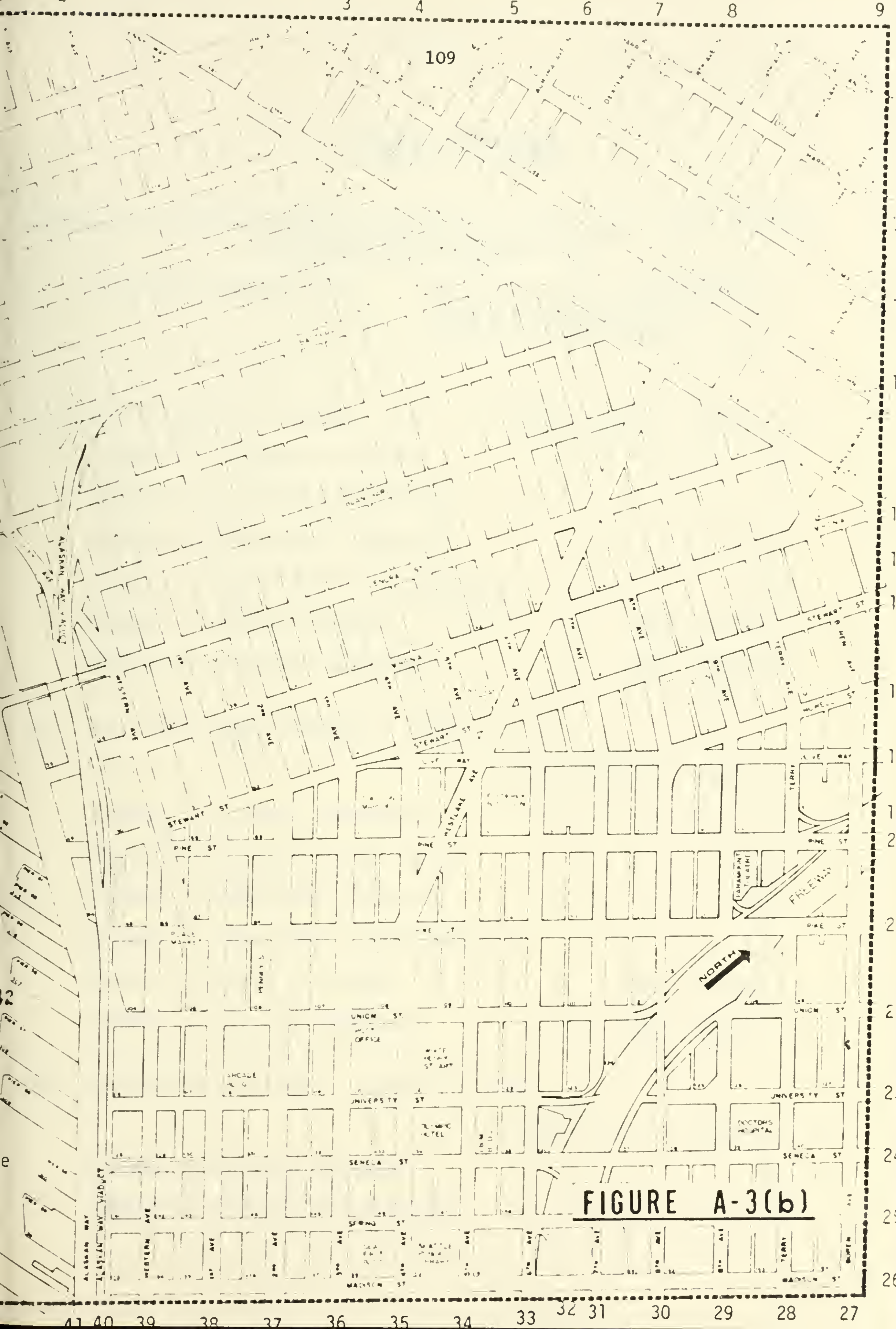


FIGURE A-3(b)

TABLE A-1(a)

SUMMARY OF SEVERAL BUILDINGS SURVEYED DURING THE 1970 "DOWNTOWN COMPREHENSIVE PARKING STUDY"

A Study Conducted By: Victor O. Gray and Company
Consulting Engineers
Seattle, Washington

I. LOGAN BUILDING (Bldg. # 46) - Block # 110 (Survey # 1)

Number Of Offices Surveyed	-	35
Number Of Offices Given Forms	-	31
Number Of Employees Reported	-	451
Number Of Forms Left For Employees	-	453
Number Of Forms Returned	-	299 (66.00%)
Number Of Visitors Reported	-	1582 (350.8%)

II. 1411 4th AVENUE BUILDING (Bldg. # 72) - Block # 108 (Survey # 1)

Number Of Offices Surveyed	-	72
Number Of Offices Given Forms	-	61
Number Of Employees Reported	-	465
Number Of Forms Left For Employees	-	465
Number Of Forms Returned	-	372 (80.00%)
Number Of Visitors Reported	-	1534 (329.9%)

III. SECURITIES BUILDING (Bldg. # 1054) - Block # 54 (Survey # 3)

Number Of Offices Surveyed	-	77
Number Of Offices Given Forms	-	69

TABLE A-1(b)

Number Of Employees Reported	-	656
Number Of Forms Left For Employees	-	652
Number Of Forms Returned	-	541 (82.97%)
Number Of Visitors Reported	-	285 (43.44%)

IV. WASHINGTON PLAZA HOTEL (Bldg. # 1056) - Block # 56 (Survey # 3)

Number Of Offices Surveyed	-	1
Number Of Offices Given Forms	-	1
Number Of Employees Reported	-	330
Number Of Forms Left For Employees	-	330
Number Of Forms Returned	-	178 (53.93%)
Number Of Visitors Reported	-	200 (60.60%)

V. MEDICAL AND DENTAL BUILDING (Bldg. # 1075) - Block # 75 (Survey # 3)

Number Of Offices Surveyed	-	222
Number Of Offices Given Forms	-	181
Number Of Employees Reported	-	598
Number Of Forms Left For Employees	-	620
Number Of Forms Returned	-	523 (84.35%)
Number Of Visitors Reported	-	3354 (560.9%)

VI. TOWER BUILDING (Bldg. # 1076) - Block # 76 (Survey # 3)

Number Of Offices Surveyed	-	55
Number Of Offices Given Forms	-	50

TABLE A-I(c)

Number Of Employees Reported	-	646
Number Of Forms Left For Employees	-	681
Number Of Forms Returned	-	477 (70.04%)
Number Of Visitors Reported	-	389 (60.21%)

TABLE A-II(a)

DATA FROM VICTOR O. GRAY AND COMPANY'S SURVEY # 1

QUESTION	Bldg. 46	Bldg. 72	Sub Total	Survey # 3 Sub Total	Surveys # 1 & # 3 Total
4. HOW DID YOU ARRIVE AT WORK TODAY?					
(1) Drove Vehicle	132	195	327	930	1257(52.68%)
(2) Passenger In Auto That Parked Downtown	22	22	44	109	153(6.41%)
(3) Dropped Off, Car Did Not Park	31	40	71	159	230(9.64%)
(4) Bus	98	102	200	458	658(27.58%)
(5) Walked	11	9	20	37	57(2.39%)
(6) Taxi Or Other	0	2	2	6	8(0.34%)
(7) Ferry	4	1	5	18	23(0.96%)
No Comment	1	1	2	2	4
TOTAL	299	372	671	1719	2390
5. DIRECTION DATA					
Direction 2 (North)	69	106	175		
(1) I-5 From North	51	78	129		
(2) Fairview; Westlake	1	1	2		
(3) Aurora; Dexter	9	14	23		
(4) Queen Anne; 5th Ave	4	1	5		
(5) Elliott Ave W.	4	12	16		
Direction 3 (East)	23	32	55		
(1) Yesler Way;James St.	1	2	3		
(2) Pine St; Pike St.	2	9	11		

TABLE A-11(b)

SURVEY # 1 DATA (CONTINUED)

QUESTION	Bldg. 46	Bldg. 72	Sub Total	Survey # 3 Sub Total	Surveys # 1 & # 3 Total
(3) E.Madison;Seneca St	8	12	20		
(4) Olive Way	0	1	1		
(5) Dearborn St.	12	8	20		
Other	18	24	42		
No Comment	0	2	2		
TOTAL	202	302	504		
6. WALKING DATA					
0 feet 100 200	34 0 0	0 0 0	34 0 0	296	330(28.28%)
300 400 500	1 10 0	18 16 0	19 26 0	134	179(15.34%)
600 700 800	12 0 9	2 6 13	14 6 22	183	225(19.28%)
900 1000 1100	2 11 4	0 5 23	2 16 27	95	140(12.00%)
1200 1300 1400	0 0 12	3 19 26	3 19 38	42	102(8.74%)
1500 1600 1700	2 0 11	2 10 5	4 10 16	43	73(6.26%)
1800 1900 2000	1 0 1	0 7 0	1 7 1	29	38(3.26%)
2100 2200 2300	3 2 2	0 2 0	3 4 2	19	28(2.40%)
2400 2500 2600	1 0 0	7 4 1	8 4 1	11	24(2.06%)

TABLE A-II(c)

SURVEY # 1 DATA (CONTINUED)

QUESTION	Bldg. 46	Bldg. 72	Sub Total	Survey # 3 Sub Total	Surveys # 1 & # 3 Total
2700 feet 2800 2900	3 0 0	2 0 0	5 0 0	7	12(1.03%)
3000 3100 3200	2 0 0	1 3 0	3 3 0	3	9(0.77%)
3300 3400 3500	1 0 0	0 0 0	1 0 0	3	4(0.34%)
3600 3700 3800	0 0 0	2 0 0	2 0 0	0	2(0.17%)
3900 4000 over 4000	0 0 0	0 0 0	0 0 0	1 1	1(0.09%) 1(0.09%)
No Comment	8	18	26	64	90
TOTAL			327	930	1257
7. IN WHAT TYPE OF SPACE DID YOU PARK?					
(1) Public Off-Street	48	87	135	723	858(69.36%)
(2) Private Facility	71	84	155	74	229(18.51%)
(3) Curb Space	12	21	33	117	150(12.23%)
No Comment	1	3	4	16	20
TOTAL			327	930	1257
8. ABOUT HOW LONG DO YOU PARK EACH DAY?					
(1) 4 hrs. or less	3	25	28	88	116(9.32%)
(2) 4 hrs. or more	128	167	295	833	1128(90.68%)
No Comment	1	3	4	9	13
TOTAL			327	930	1257

TABLE A-11(d)

SURVEY # 1 DATA (CONTINUED)

QUESTION	Bldg. 46	Bldg. 72	Sub Total	Survey # 3 Sub Total	Surveys # 1 & # 3 Total
9. DO YOU PAY TO PARK?					
(1) Yes	125	175	300	818	1118(91.12%)
(2) No	7	17	24	85	109(8.88%)
No Comment	0	3	3	27	30
TOTAL			327	930	1257
10. DO YOU PARK?					
(1) By The Hour	13	27	40	104	144(12.48%)
(2) By The Day	57	41	98	220	318(27.56%)
(3) By The Month	59	116	175	517	692(59.96%)
No Comment	3	11	14	89	103
TOTAL			327	930	1257
ORIGIN INFORMATION (PEOPLE IN ZIP LOCATIONS)					
004 (Bellevue)	29	34	63	130	193(4.28%)
011 (Bothell)	2	2	4	27	31(2.07%)
020 (Edmonds)	6	12	18	35	53(3.55%)
033 (Kirkland)	12	14	26	32	58(3.88%)
036 (Lynnwood)	2	3	5	18	23(1.54%)
043	1	3	4	11	15(1.00%)
052 (Redmond)	1	3	4	8	12(0.80%)
072 (Woodenville)	2	0	2	2	4(0.27%)
102	24	32	56	150	206(13.78%)
103	16	15	31	76	107(7.16%)
105	10	25	35	69	104(6.96%)
107	14	17	31	74	105(7.02%)
109	18	10	28	55	83(5.55%)
115	16	25	41	99	140(9.36%)
119	11	10	21	54	75(5.02%)
122	7	6	13	29	42(2.81%)

TABLE A-II (e)

SURVEY # 1 DATA (CONTINUED)

QUESTION	Bldg. 46	Bldg. 72	Sub Total	Survey # 3 Sub Total	Surveys # 1 & # 3 Total
125	4	11	15	57	72(4.82%)
133	9	9	18	50	68(4.55%)
155	12	13	25	58	83(5.55%)
177	4	7	11	37	48(3.21%)
199	6	17	23	79	102(6.82%)
TOTAL			474	1150	1624(100.0%)

TABLE A-III(a)

DATA FROM VICTOR O. GRAY AND COMPANY'S SURVEY # 3

QUESTION	Bldg. 1054	Bldg. 1056	Bldg. 1075	Bldg. 1076	Sub Total
4. HOW DID YOU ARRIVE AT WORK TODAY?					
(1) Drove Vehicle	272	102	261	295	930
(2) Passenger In Auto That Parked Downtown	33	5	41	30	109
(3) Dropped Off; Vehicle Did Not Park Downtown	55	23	46	35	159
(4) Bus	156	36	163	103	458
(5) Walked From Home	13	9	9	6	37
(6) Taxi Or Other	4	1	1	0	6
(7) Ferry	8	1	1	8	18
No Comment	0	1	1	0	2
TOTAL	541	178	523	477	1719
5. IF YOU ARRIVED AT WORK TODAY BY AUTO, HOW MANY PEOPLE WERE IN THE VEHICLE? (COUNT YOURSELF AS 1)					
(1) 1 Person	221	94	230	266	811
(2) 2 Persons	108	30	93	68	299
(3) 3 Persons	21	5	16	20	62
(4) 4 Persons	7	1	2	5	15
(5) 5 Persons	3	0	2	0	5
No Comment	181	48	180	118	527
TOTAL	541	178	523	477	1719
7. WALKING DATA					
0 feet	92	0	25	16	

TABLE A-III(b)

SURVEY # 3 DATA (CONTINUED)

QUESTION	Bldg. 1054	Bldg. 1056	Bldg. 1075	Bldg. 1076	Sub Total
100 feet	52	31	3	49	296
200 feet	9	4	7	8	
300 feet	16	13	21	11	
400 feet	3	9	1	28	134
500 feet	10	3	4	15	
600 feet	4	5	53	57	
700 feet	0	3	17	3	183
800 feet	9	8	17	7	
900 feet	9	1	7	7	
1000 feet	0	2	21	24	95
1100 feet	11	3	9	1	
1200 feet	1	1	2	4	
1300 feet	4	0	11	5	42
1400 feet	4	1	5	4	
1500 feet	6	0	3	3	
1600 feet	1	2	6	11	43
1700 feet	1	1	2	7	
1800 feet	2	0	6	6	
1900 feet	2	0	2	0	29
2000 feet	0	2	9	0	
2100 feet	2	0	0	2	
2200 feet	5	3	2	1	19
2300 feet	2	0	2	0	
2400 feet	1	0	1	2	
2500 feet	1	0	0	1	11
2600 feet	1	0	0	4	
2700 feet	1	0	1	0	
2800 feet	1	0	1	0	7
2900 feet	0	2	0	1	
3000 feet	1	0	0	0	
3100 feet	0	1	0	0	3
3200 feet	0	0	0	1	
3300 feet	0	0	0	0	
3400 feet	0	1	0	1	3
3500 feet	1	0	0	0	
3600 feet	0	0	0	0	
3700 feet	0	0	0	0	0
3800 feet	0	0	0	0	
3900 feet	0	0	0	0	
4000 feet	0	0	0	0	1
over 4000 feet	0	0	0	1	
No Comment	20	6	23	15	64
TOTAL					930

TABLE A-III (c)

SURVEY # 3 DATA (CONTINUED)

QUESTION	Bldg. 1054	Bldg. 1056	Bldg. 1075	Bldg. 1076	Sub Total
8. IN WHAT TYPE OF SPACE DID YOU PARK TODAY?					
(1) Off-Street Facility For Public Usage	230	58	234	201	723
(2) Off-Street Space Provided By Employer	5	11	16	42	74
(3) Curb Space	32	29	6	50	117
No Comment	5	4	5	2	16
TOTAL					930
9. HOW LONG DID YOU PARK TODAY?					
(1) Less Than 2 hrs.	17	0	3	8	28
(2) 2 - 4 hrs.	20	2	13	25	60
(3) 4 - 6 hrs.	17	7	25	33	82
(4) 6 - 8 hrs.	96	31	95	85	307
(5) More than 8 hrs.	120	61	120	143	444
No Comment	2	1	5	1	9
TOTAL					930
10. A. DO YOU PAY TO PARK?					
(1) Yes	258	67	240	253	818
(2) No	10	31	12	32	85
No Comment	4	4	9	10	27
TOTAL					930

TABLE A-III(d)

SURVEY # 3 DATA (CONTINUED)

QUESTION	Bldg. 1054	Bldg. 1056	Bldg. 1075	Bldg. 1076	Sub Total
B. IF YES, DO YOU PAY?					
(1) By The Hour	41	16	15	32	104
(2) By The Day	70	36	55	59	220
(3) By The Month	150	18	178	171	517
No Comment	11	32	13	33	89
TOTAL					930
6. DIRECTION DATA? (SEE ACCOMPANYING FIGURE A - 3 (b))					
Route 1	0	0	0	0	0
Route 2	16	9	17	7	49
Route 3	4	3	2	2	11
Route 4	0	0	0	0	0
Route 5	0	0	0	0	0
Route 6	26	7	11	18	62
Route 7	10	2	6	6	24
Route 8	1	0	1	1	3
Route 9	6	3	8	1	18
Route 10	0	0	0	0	0
Route 11	0	1	0	0	1
Route 12	0	0	0	0	0
Route 13	0	1	2	1	4
Route 14	3	1	2	3	9
Route 15	0	0	0	0	0
Route 16	80	28	78	126	312
Route 17	0	1	1	0	2
Route 18	0	2	7	7	16
Route 19 (I-5 from North)	10	2	25	8	45
Route 20	8	3	17	7	35
Route 44	0	0	0	0	0
Route 45	0	0	0	0	0
Route 46	0	0	1	0	1
Route 47	1	1	2	0	4
Route 48	0	0	0	0	0
Route 49	0	0	0	0	0
Route 50	2	0	0	0	2
No Comment	7	9	7	3	26
TOTAL					624

TABLE A-III(e)

SURVEY # 3 DATA (CONTINUED)

QUESTION	Bldg. 1054	Bldg. 1056	Bldg. 1075	Bldg. 1076	Sub Total
ORIGIN INFORMATION (PEOPLE IN ZIP LOCATIONS)					
004 (Bellevue)	43	4	27	56	130
020 (Edmonds)	12	2	12	9	35
011 (Bothell)	12	5	4	6	27
033 (Kirkland)	8	2	9	13	32
036 (Lynnwood)	6	1	5	6	18
043	5	2	2	2	11
052 (Redmond)	5	0	0	3	8
072 (Woodinville)	0	1	0	1	2
102	34	12	66	38	150
103	21	12	22	21	76
105	15	7	22	25	69
107	21	5	25	23	74
109	19	8	17	11	55
115	28	7	40	24	99
119	19	4	18	13	54
122	10	8	4	7	29
125	19	5	19	14	57
133	15	7	12	16	50
155	18	3	22	15	58
177	10	3	15	9	37
199	24	10	30	15	79
TOTAL					1150

APPENDIX B

The following pages contain a tabulated, block-by-block, estimation of long-term parking supply and demand. Additionally, discussion of some walking distance factors and characteristics is presented, especially as related to time and distance savings.

Figure B-1 illustrates the downtown area encompassed by this investigation's designated study area. Keeping this particular section of Seattle's CBD in mind, tabulation of block-by-block long-term parking supply and demand is presented in Table B-I. The data presented is from a "Downtown Comprehensive Parking Study" by Victor O. Gray and Company, Consulting Engineers, Seattle, Washington. Table B-II illustrates for several designated blocks the calculations conducted by the V. O. Gray Company in arriving at the various supply and demand estimations. Of course, a long-term parking supply figure is arrived at simply by careful inventory of the spaces contained in each block. Demand, on the other hand, is estimated based on three factors, namely: (1) Land usage, as designated by the Puget Sound Governmental Conference (see Figure B-2), (2) Area of each floor space usage as determined by careful inventory, and (3) A Long Term Parking Generating Multiple, or Factor. This latter term is a unique factor calculated for each different land usage within a particular block in the downtown area. Figure B-3 illustrates in detail the derivation of an example generating factor.

Based on the walking distance data found in Table A-2 and A-3 in Appendix A, Table B-III is derived which summarizes the cumulative percentage of walkers as a function of distance walked. The table is carried out to a walking distance of 1500 feet, which encompasses 85.02% of the people reporting in the Victor O. Gray study. Of equal interest are the reverse cumulation figures which show the percentage of the whole which walk some distance

NORTH SEATTLE CBD –
DESIGNATED DOWNTOWN
MONORAIL STUDY AREA

Eldon C Schierman August 8,1971

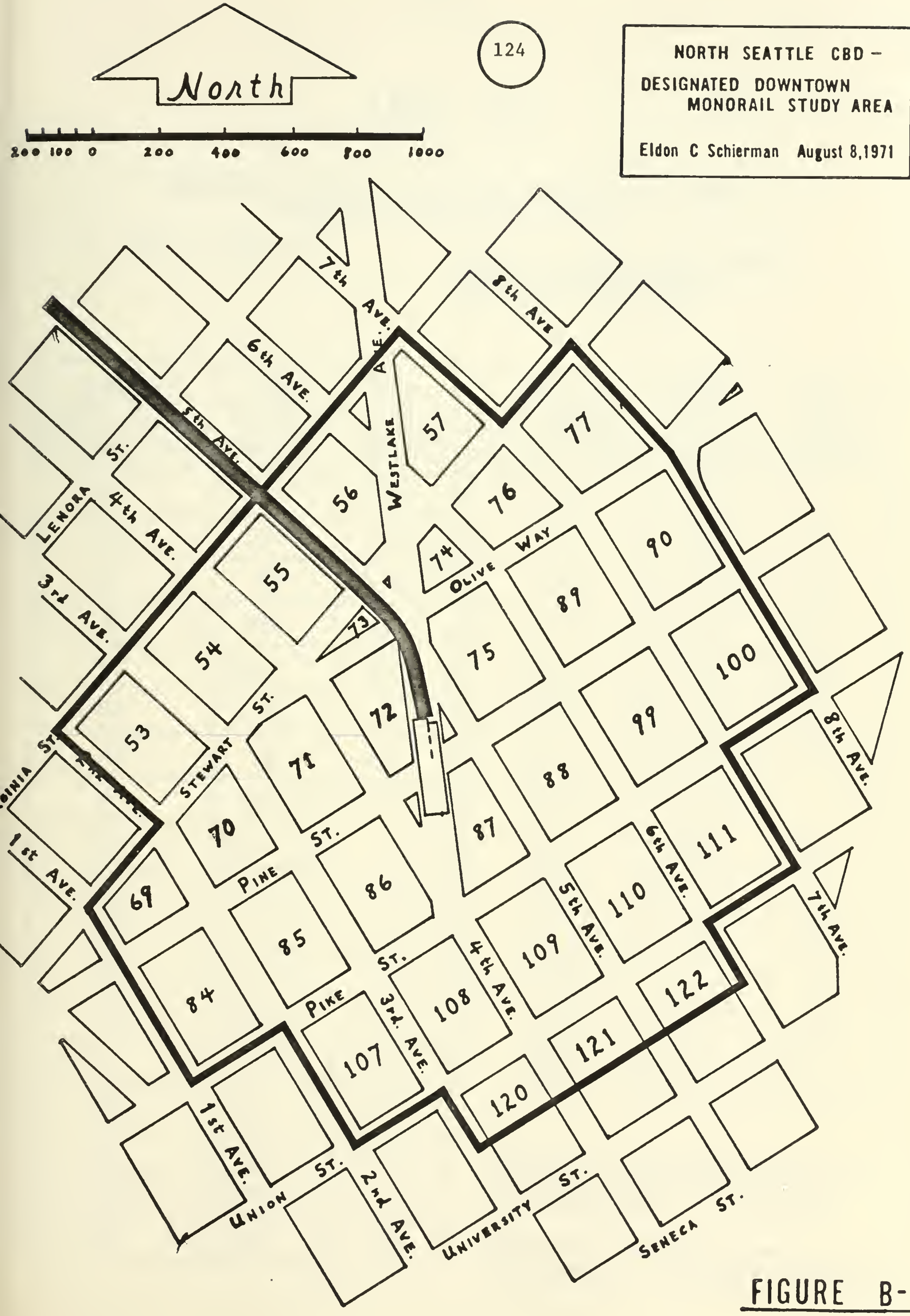


FIGURE B-1

TABLE B-1

SUMMARIZED TOTALS, BY BLOCK, OF THE LONG TERM PARKING SUPPLY AND DEMAND

From A Study By: Victor O. Gray and Company
Consulting Engineers
Seattle, Washington

Block # From "Dwntwn. Comprehensive Parking Study	Long Term Parking Demand	Long Term Parking Supply
53	83	50
54	307	536
55	97	450
56	420	350
57	464	350
69	50	0
70	38	932
71	566	0
72	149	0
73	40	0
74	45	40
75	916	68
76	593	360
77	38	75
84	112	125
85	386	415
85	184	0
87	267	0

Block # From "Dwntwn. Comprehensive Parking Study	Long Term Parking Demand	Long Term Parking Supply
88	260	0
89	622	750
90	62	188
99	204	14
100	107	176
107	388	400
108	607	0
109	330	0
110	392	200
111	36	110
120 (½)	319	300
121 (½)	355	64
122 (½)	176	188
TOTAL	7713	6141

Percent Of Long Term Parking Demand With Origins North Of Study Area - 62.55%

Adjusted Long Term Demand - (7713spaces) (0.6255)= 4824emp.

TABLE B-II

EXAMPLE DETAILED TABULATION OF THE LONG TERM PARKING SUPPLY AND DEMAND FOR SEVERAL OF THE BLOCKS IN THE SURVEY AREA

From A Study By: Victor O. Gray and Company
Consulting Engineers
Seattle, Washington

BLOCK # From "Downtown Comprehensive Parking Study"	Usage Code (P.S.G.C)	Floor Space (sq ft)	Long Term Parking Generating Factor	Long Term Parking Demand	Long Term Parking Supply
69	18 58 61 62 65 69	32299 6200 3500 3300 8000 15200	0.05 0.30 2.00 1.50 2.50 1.20	6 2 7 5 12 18	
TOTAL		68500		50	0
70	57 61	29000 14900	0.50 1.50	15 23	
TOTAL		43900		38	932
72	18 49 54 56 57 58 59 61 62 63 65 66 73	84700 700 1500 34900 21600 18200 28500 9600 2300 5100 2900 500 3300	0.32 0.00 0.00 0.50 0.50 0.50 0.50 1.50 1.20 1.20 3.00 0.00 0.00	63 0 0 18 11 9 14 15 3 6 9 0 0	
TOTAL		213799		149	0
73	65	30000	1.33	40	
TOTAL		30000		40	0

PARKING GENERATING FACTOR - SUMMARY

PSGC CODE	LAND USE Description	LONG TERM PARKING Demand Factor/1000 S.F.
11	Res - Single Family	.50 - 1.00
12	Res - 2 to 4 Units	.50 - 1.00
13	Res - 5 to 19 Units	.10 - .60
14	Res - 20+ Units	.05 - .77
15	Group Quarters	.30
16	Res. Hotels	.02 - .55
18	Transient Lodge	.05 - .55
21	Food, Bev. Mfg.	.50 - 1.42
22	Textile Mfg.	.50 - 1.00
23	Apparel Mfg.	.60 - .80
24	Lumber, Wood Prod. Mfg.	1.00 - 2.50
26	Paper Products Mfg.	1.00 - 1.54
27	Print. Pub. Mfg.	1.40 - 2.00
28	Chemical Mfg.	.80 - 1.80
31	Rubber, Plastic Mfg.	1.50
33	Primary Metal Mfg.	.60 - 2.20
34	Fabr. Metal Mfg.	1.00 - 3.00
35	Science Equip. Mfg.	1.50 - 2.00
39	Misc. Mfg.	1.00 - 2.00
32	Stone, Clay & Glass Mfg.	1.00 - 2.00
41	R.R. Term. & Yard	1.00 - 2.20
42	Transp. Local	.20 - .50
43	Transp. Air	.40 - 1.50
44	Transp. Marine	.60 - 3.00
47	Communications	1.50 - 2.20
48	Utilities	1.00 - 2.00
49	Transp. Other	.50 - 2.50
51	Whsle. Trade	.40 - 2.20
52	Lumber, Hardware Retail	.70 - 1.10
53	General Retail	.51 - 1.10
54	Food Retail	.10 - .80
55	Service Station	.10 - 1.20
56	Apparel Retail	.50 - .70
57	Furniture Retail	.30 - .80
58	Eat & Drink Establish.	.40 - 1.50
59	Other Retail	.40 - 1.00
61	Finance, Insurance, Real Est.	1.50 - 2.50
62	Personal Services	.50 - 1.50
63	Business Services	.50 - 2.50
64	Repair Services	.60 - 1.50
65	Professional Services	1.50 - 2.50
66	Construction	.50 - 1.00
67	Gov't. Offices & Services	1.50 - 2.30
68	School	.50 - 1.00
69	Misc. Services	.50 - 1.00
71	Cultural Center	.20 - 1.00
72	Public Assembly	.20 - .60
73	Amusements	.50 - 1.00
74	Rec. Activities	.50
83	Forest Services	1.00
85	Mining	1.00
	New Office Bldgs. ('66-'70)	1.00 - 2.00

FIGURE B-2

TABLE NO. 9

PROGRAM NAME: DEFAC

PARKING SURVEY: LONG TERM

DEMAND FACTOR DERIVATION:

Land use to be analyzed is surveyed with an employee questionnaire form to determine parking characteristics. The following information is available from the survey:

1. Land use code of area surveyed.
2. Sq. Ft. area.
3. Number of employees.
4. Number forms returned.
5. Parkers with duration over 4 hours.

ADJUST FOR SURVEY RETURN:

$$\text{Sum of parkers} \times \frac{\text{No. employees}}{\text{No. forms returned}} = \text{Adjusted demand.}$$

FIND DEMAND/1000 S.F. Area

$$\frac{\text{Adjusted demand} \times 1000}{\text{Sq. Ft. Area}} = \text{Demand Factor}$$

EXAMPLE:	Land Use Code:	6700
	Sq. Ft. Area	2500
	Employees	10
	Forms returned:	5
	Parkers over 4 hrs.:	4

ADJUST FOR SURVEY RETURN

$$4 \times \frac{10}{5} = 8 \quad \text{Adjusted Demand}$$

FIND DEMAND/1000 S.F. AREA:

$$\frac{8 \times 1000}{2500} = 3.2 \quad \text{Demand Factor}$$

FIGURE B-3 (a)

PROGRAM NAME: DEFAC

PARKING SURVEY: LONG TERM

DESCRIPTION: The program calculates demand factors, i.e., the number of long term parkers per 1000 sq. ft. of office space, for each individual land use. A demand factor is printed for each of six ranges of office areas for every land use encountered in the survey data. The ranges of office areas are as follows:

Sq. Ft. Range	Area
1	Includes all areas
2	0 - 500 sq. ft.
3	501 - 1500
4	1501 - 5000
5	5001 - 25,000
6	Greater than 25,000 sq. ft.

For a land use category the program sums and prints the number of offices, the office areas, the number of long term parkers, and the demand factor for each of the above ranges of areas. Since data was not available for all employees in the offices, the percentage of long term parkers in an office was assumed to be the same as the percentage of long term parkers among those responding to the survey. Thus, the total number of long term parkers is referred to as the "ADJUSTED MODE 1 DEMAND" in the output. The DEMAND FACTOR is found by dividing the sum of long term parkers in each range by the sum of the office areas in each range.

FIGURE B-3(b)

TABLE B-III

SEATTLE CBD - MONORAIL FEASIBILITY STUDY AREA
WORK TRIP WALKING CHARACTERISTICS

From A Study Conducted By: Victor O. Gray and Company
Consulting Engineers
Seattle, Washington

(A) Walking Distance (feet)	(B) Survey # 1	(C) Survey # 3	(D) Total Walkers (B+C)	(E) % Of Total Walk Trips	(F) Cummu-lative %	(G) % Trips Greater Than (A) (100-F)
0	34	133	167	14.31	14.31	85.69
100	0	135	135	11.57	25.88	74.12
200	0	28	28	2.40	28.28	71.72
300	19	61	80	6.86	35.14	64.86
400	26	41	67	5.74	40.88	59.12
500	0	32	32	2.74	43.62	56.38
600	14	119	133	11.40	55.02	44.98
700	6	23	29	2.49	57.51	42.49
800	22	41	63	5.40	62.91	37.09
900	2	24	26	2.23	65.14	34.86
1000	16	47	63	5.40	70.54	29.46
1100	27	24	51	4.37	74.91	25.09
1200	3	8	11	0.94	75.85	24.15
1300	19	20	39	3.34	79.19	20.81
1400	38	14	52	4.46	83.65	16.35
1500	4	12	16	1.37	85.02	14.98
TOTAL:			992			

Total Walk Trips In Survey - 1167 992/1167 = 85.02%

TABLE B-IV(a)

ESTIMATED ATTRACTION OF ALL-DAY PARKERS TO AN EXTENDED MONORAIL "PARK-AND-RIDE" SYSTEM BASED ON SAVINGS IN WALKING DISTANCE CRITERIA

From A Study By: Victor O. Gray & Company
Consulting Engineers
Seattle, Washington

(A) Radial Dist. From CBD Mono. Term. (in feet)	(B) Dwntwn. Block #	(C) Per Cent of Block Included (%)	(D) Long Term Parking Demand For Block	(E) Adjusted Lt Parking Demand (C)x(D)	(F) % Walk Trips Great. Than Radial Distance (A)	(G) Tot. Per. Attracted To Mono. (E)x(F)
0	-	-	-	-	85.69	0
0-100	72	10	149	14.9	74.12	11
	87	5	267	13.4		10
Total				28.3	74.12	21
100-200	72	30	149	44.7	71.72	32
	75	2	916	18.3		13
	87	25	267	66.8		48
	88	1	260	2.6		2
Total				132.4	71.72	95
200-300	71	15	566	84.9	64.86	55
	72	30	149	44.7		29
	75	20	916	183.2		119
	86	12	184	22.1		14
	87	30	267	80.1		52
	88	19	260	49.4		32
Total				464.4	64.86	301
300-400	71	37	566	209.4	59.12	124
	72	30	149	44.7		26
	75	40	916	366.4		217
	86	30	184	55.2		33
	87	36	267	96.1		57
	88	35	260	91.0		54
Total				862.8	59.12	511
400-500	71	38	566	215.1	56.38	121
	73	100	40	40.0		23
	75	30	916	274.8		155
	86	40	184	73.6		41
	87	4	267	10.7		6
	88	35	260	91.0		51
	109	2	330	6.6		4
Total				711.8	56.38	401

TABLE B-IV(b)

(A) Radial Dist. From CBD Mono. Term. (in feet)	(B) Dwntwn. Block #	(C) Per Cent of Block Included (%)	(D) Long Term Parking Demand For Block	(E) Adjusted Lt Parking Demand (C)x(D)	(F) % Walk Trips Great. Than Radial Distance (A)	(G) Tot. Per. Attracted To Mono. (E)x(F)
500-600	54	16	307	49.1	44.98	22
	55	19	97	18.4		8
	70	25	38	9.5		4
	71	10	566	56.6		25
	74	50	45	22.5		10
	75	8	916	73.3		33
	85	20	386	77.2		35
	86	18	184	33.1		15
	88	10	260	26.0		12
	89	30	95	28.5		13
	99	25	204	51.0		23
	108	11	607	66.8	44.98	30
	109	30	330	99.0		45
	110	14	392	54.9		25
Total				665.9	44.98	300
600-700	53	5	83	4.2	42.49	2
	54	28	307	86.0		37
	55	27	97	26.2		11
	56	15	420	63.0		27
	70	45	38	17.1		7
	74	50	45	22.5		10
	76	5	593	29.7		13
	85	35	386	135.1		57
	89	40	95	38.0		16
	99	43	204	87.7		37
	108	27	607	163.9		70
	109	30	330	99.0		42
	110	31	392	121.5		52
	111	1	36	0.4		0
Total				894.3	42.49	381
700-800	53	23	83	19.1	37.09	7
	54	28	307	86.0		32
	55	27	97	26.2		10
	56	25	420	105.0		39
	70	30	38	11.4		4
	76	37	593	219.4		81
	85	35	386	135.1		50
	89	28	95	26.6		10
	99	30	204	61.2		23
	107	7	15	1.1		0
	108	30	607	182.1		68
	109	30	330	99.0		37

TABLE B-IV(c)

(A) Radial Dist. From CBD Mono. Term (in feet)	(B) Dwntwn. Block #	(C) Per Cent of Block Included (%)	(D) Long Term Parking Demand For Block	(E) Adjusted Lt Parking Demand (C)x(D)	(F) % Walk Trips Great. Than Radial Distance (A)	(G) Tot. Per. Attracted To Mono. (E)x(F)
700-800 Cont.	110	32	392	125.4		47
	111	14	36	5.0		2
Total				1102.6	37.09	410
800-900	53	30	83	24.9	34.86	9
	54	26	307	79.8		28
	55	27	97	26.2		9
	56	32	420	134.4		47
	57	10	464	46.4		16
	69	20	50	10.0		3
	76	43	593	255.0		89
	84	10	112	11.2		4
	85	10	386	38.6		13
	89	2	95	1.9		1
	90	20	62	12.4		4
	99	2	204	4.1		1
	100	20	107	21.4		7
	107	27	15	4.1		1
	108	27	607	163.9		57
	109	8	330	26.4		9
	110	22	392	86.2		30
	111	35	36	12.6		4
Total				959.5	34.86	332
900-1000	53	30	83	24.9	29.46	7
	54	2	307	6.1		2
	56	25	420	105.0		31
	57	35	464	162.4		48
	69	50	50	25.0		7
	76	15	593	89.0		26
	77	16	38	6.1		2
	84	40	112	44.8		13
	90	40	62	24.8		7
	100	20	107	21.4		6
	107	36	15	5.4		2
	108	5	607	30.4		9
	110	1	392	3.9		1
	111	35	36	12.6		4
Total				561.8	29.46	165

TABLE B-IV(d)

SUMMARY OF ATTRACTION BASED ON
SAVINGS IN WALKING DISTANCE CRITERIA

Radial Distance From CBD Monorail Terminal (in feet)	Total Persons Attracted To Monorail (based on savings in walking distance)
0	0
0-100	21
100-200	95
200-300	301
300-400	511
400-500	401
500-600	300
600-700	381
700-800	410
800-900	332
900-1000	165
Total	2917

greater than a specified distance. These values are listed in column G of Table B-III and are carried over to column F of Table B-IV.

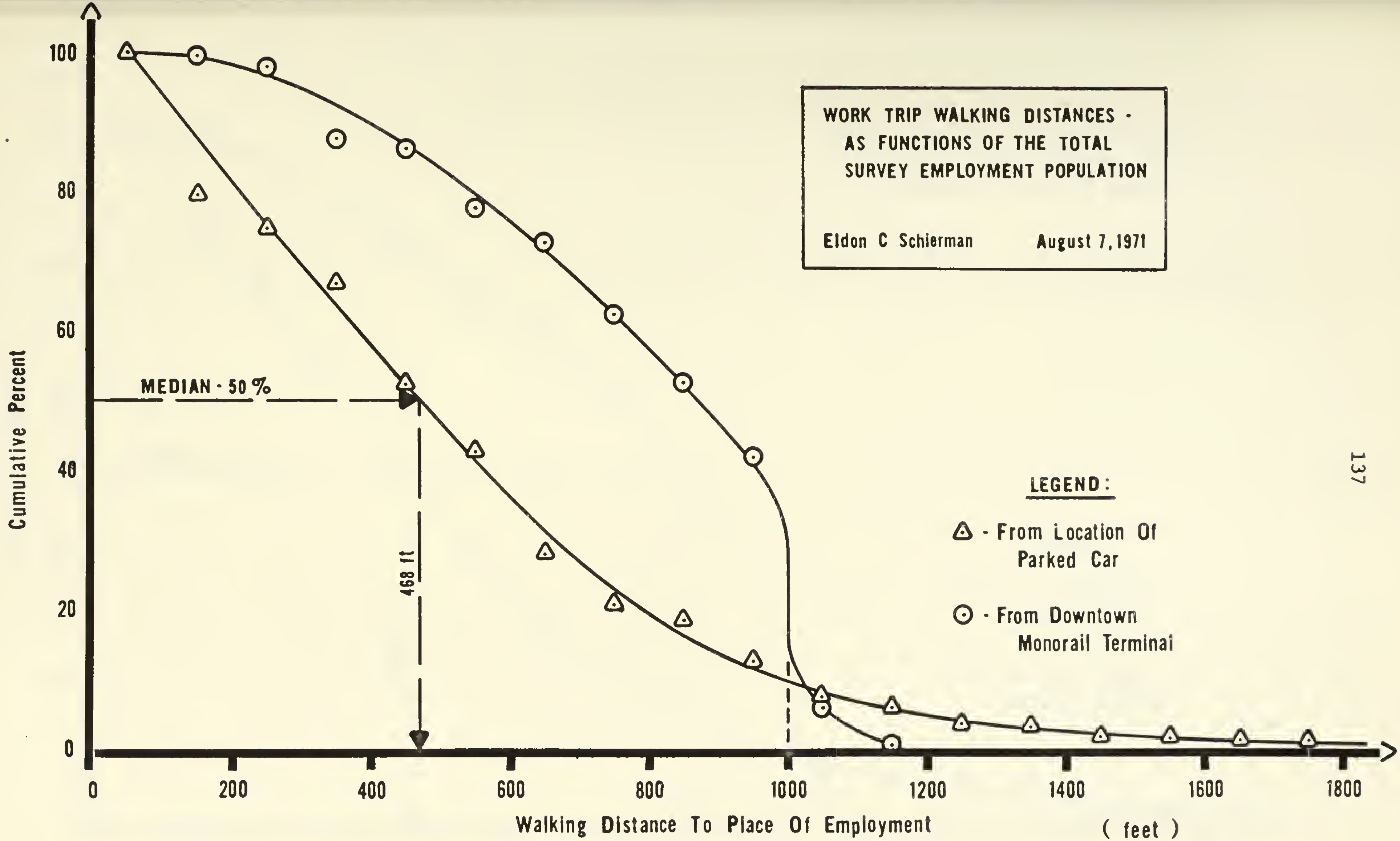
Table B-IV shows an attempt to estimate the number of employed individuals in the designated study area who could be expected to save walking distance by opting to park at the Seattle Center and ride the Monorail rather than continue with their present parking arrangements. Concentric circles of 100 foot increments are drawn around the Westlake Mall Monorail Terminal from 0 feet radius to 1000 foot radius. The applicable blocks, or percentage of blocks, contained by the circles are listed and the long term demand is estimated as based on the percent of each block enclosed and the estimated demand for the entire block (see Table B-I). This figure is adjusted by the reverse cumulative percentages which are listed in Table B-III, column G. The final totals (column G) shown in Table B-IV show an estimate of the number of parkers contained within a given radius of the downtown Monorail terminal who could be expected to save some walking distance by making use of the proposed Monorail "park-and-ride" system.

From the figures listed in Table B-IV, it is evident that for approximately 2917 individuals who work in the study area, the Monorail terminal is closer to their place of employment than is their present parking location. It might be surmised that the figure 2917 might represent a good estimate of the system's attraction. This hypothesis, however, is not supported by the experimental data, for as indicated in Chapter II, the best estimate of the maximum possible attraction to the system is only 1525 drivers.

A further illustration that walking distance downtown has relatively little bearing on one's choice of parking location (within resonable limits) is given in Figures B-4 and B-5. The figures are plotted from data obtained

as a result of the Monorail extension acceptance survey conducted by this author. The first set of curves are plotted from the entire sample population which responded to the survey. The curves are cumulative percentage distributions for distances walked from present parking location to place of employment and, also, from the Monorail terminal to place of employment. The curves in Figure B-5 are similar, except that only data from those individuals who indicated a willingness to use the Monorail is used. It is significant to note the similarity in shape and parameters between the curves of Figure B-4 and those of Figure B-5. It can be concluded, therefore, that walking distance doesn't seem to have much bearing on whether or not an individual chooses to make use of the proposed system.

Finally, further support of the aforementioned hypothesis is given in Figure 12, page 19. From the figure it is evident that only 6.74% of the sample which responded negatively did so because of the walking distance criteria ("Present garage more conveniently located than downtown terminal"). Other factors considered more important are: (1) Availability of car for use during the day - 44.56%, (2) Convenience of driving directly downtown - 12.93%, and (3) Driving and parking time and costs - 8.29%.



WORK TRIP WALKING DISTANCES - AS FUNCTIONS OF THE TOTAL SURVEY EMPLOYMENT POPULATION
Eldon C Schierman
August 7, 1971
LEGEND:
- From Location Of Parked Car
- From Downtown Monorail Terminal
MEDIAN - 50 %
468 ft
Cumulative Percent
100
80
60
40
20
0
200
400
600
800
1000
1200
1400
1600
1800
Walking Distance To Place Of Employment
(feet)

FIGURE B-4

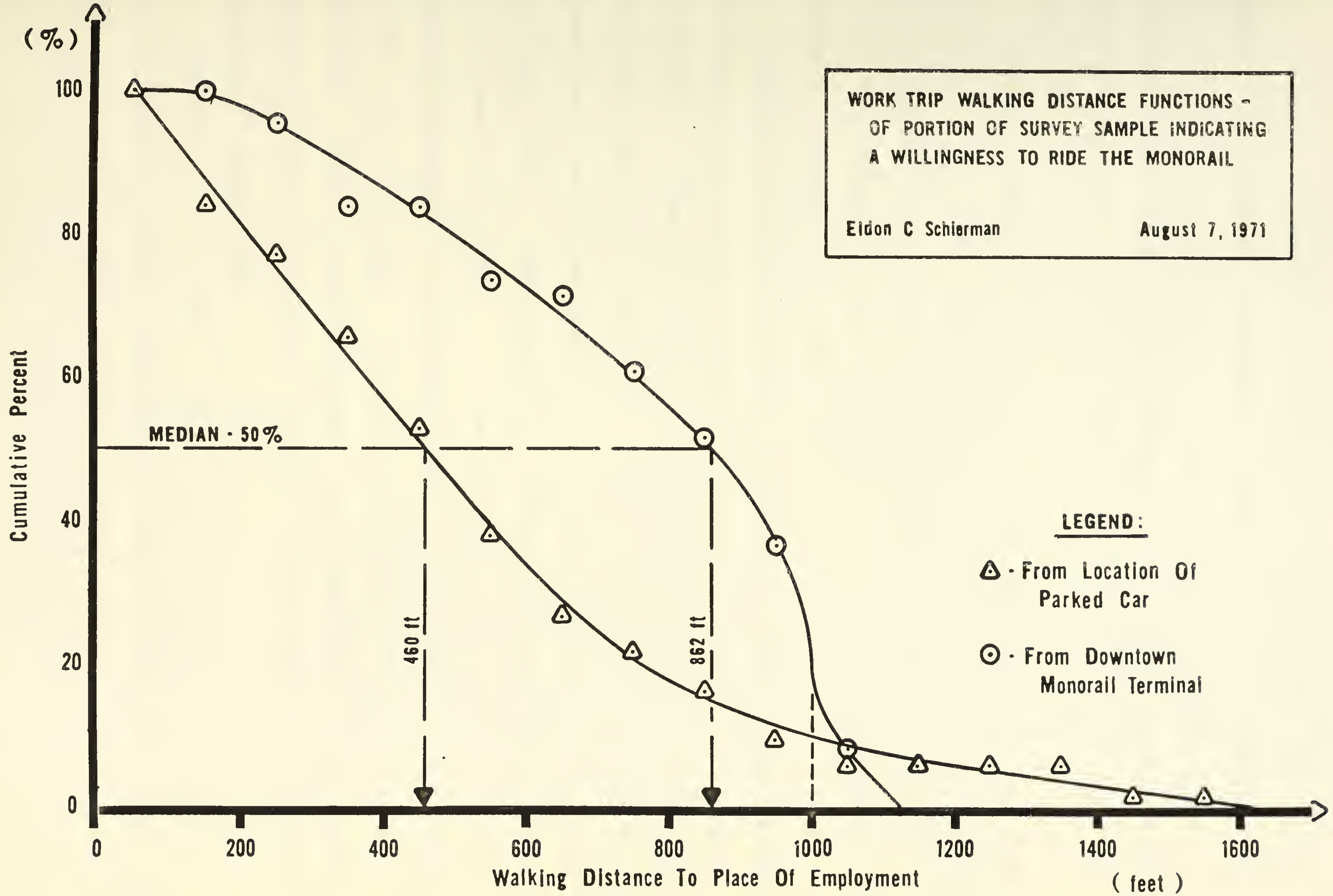

WORK TRIP WALKING DISTANCE FUNCTIONS - OF PORTION OF SURVEY SAMPLE INDICATING A WILLINGNESS TO RIDE THE MONORAIL
Eldon C Schierman
August 7, 1971
(%)
Cumulative Percent
100
80
60
40
20
0
MEDIAN - 50%
460 ft
862 ft
LEGEND:
From Location Of Parked Car
From Downtown Monorail Terminal
0
200
400
600
800
1000
1200
1400
1600
Walking Distance To Place Of Employment
(feet)

FIGURE B-5

APPENDIX C

Of vital importance to the significance of the study presented in the body of this report is the estimation of public reaction to, and usage of, the Monorail extension proposal. To this end a survey was planned and executed which measured several characteristics, including reaction to the basic proposal idea, of those individuals who work in the designated downtown study area.

The questionnaire forms which were used in the investigation are shown in Figures C-1 and C-2. Figure C-1 was the initial draft and was distributed on a test basis at one location in the study area. Results of the returns of this small sample prompted the revision of several of the questions, with Figure C-2 emerging as the final form.

Questions # 1 and # 2 are basic to the survey, as they briefly discuss the proposal idea and then question the recipient's reactions. An exhorbitant number of forms were returned during the test of the questionnaire with the first question left unanswered. This indicated that people either didn't clearly understand the meaning of the question or else failed to read the explanatory "Note A" (see Figure C-1) at the top of the page before attempting to answer the questions. As a result, the revised questionnaire (see Figure C-2) combined the information of Note A and Question # 1 into a single, clearer, simpler paragraph. The results were fewer "no comments" of that particular, vitally important question. Also incorporated into the revised Question # 1 was an opportunity to indicate the main reason for rejection of the Monorail proposal idea.

Questions # 3, # 4, and # 5 inquire about the awareness and usage of Seattle Transit's existing "park-and-ride" commuter parking lot. It was felt that this particular operation offered a similar service in the same general

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98105

ment of Civil Engineering

QUESTIONNAIRE

"Seattle Center Parking Garage and Monorail Extension Feasibility Study"

The Seattle Center Parking Garage and Monorail System presently experience ittle daytime usage, while the downtown area of Seattle is congested during the aytime. As a graduate student in traffic engineering at the University of Washngton, I am studying the feasibility of modifying and extending the Monorail to onnect directly to the parking garage at the Seattle Center. The idea is to ncourage people to park at the Seattle Center and ride the Monorail to work owntown. Modifications proposed include an extension of one rail north along th Avenue to provide direct connection of the Monorail to the second or third evel of the parking garage.

An important component of this study is the determination of the level of ublic acceptance and potential usage of the new system. For this purpose, it s cordially requested that you take a few minutes of your time to answer the nine uestions on the reverse side of this form. When completed, please fold the uestionnaire, place in the pre-addressed envelope provided, and drop in the earest mailbox.

Eldon C. Schierman
Graduate, Transportation, Materials
and Geoengineering Division
Department of Civil Engineering,
University of Washington

FIGURE C-1

Please assume that the Monorail has been extended and that the system now has a new station at the existing Seattle Center Parking Garage. Also, assume that this improvement would provide a non-stop, 3-minute ride from this garage to the downtown Monorail terminal.

idering your present parking costs in terms of time, money, and conven- e, would you be willing to park your car at the Seattle Center garage and the Monorail to work? (If your answer is "no", please skip directly to B.)

Yes___

No___

is the maximum that you would be willing to pay to park your car all day (7 a.m.- ı.) at the Seattle Center garage and ride the Monorail to work downtown. (Assume fonorail fare is included as a portion of the parking ticket charge.)

(Please indicate a Daily or a Monthly rate)

Maximum Rate per Day_____
or
Maximum Rate per Month_____

The Seattle Transit Company presently is operating an all-day "park-and-ride" parking lot near the Seattle Center. The lot is located on 5th Avenue, across from the High School Memorial Stadium. The total charge is 50¢ per day, which pays for parking your car and, also, for bus fare to and from your work downtown. Regular bus routes stop on 5th Avenue next to the lot and are frequently available (every 5 or 6 minutes) during the morning and evening rush periods.

you aware that this "park-and-ride" parking lot is in operation at the :le Center?

Yes___

No___

'es", have you ever parked your car there and taken the bus to work?

Yes___

No___

often (in work days per month) do you use the "park-and-ride" parking service?

Parking Rate_______________
(days per month)
Never use _______________

is the purpose of your trip downtown today?

Work_________

Other_________

long (in minutes) does your normal home-to-work trip take from the time you leave home until you reach the building of your place of work?

Minutes_________

is the Zip Code of your home address? _____________

is the name and/or street address of your place of work?

e)____

ress)____
Zip Code

ive any further comments, please list them in the space provided below.

____

____

ı for taking your time in filling out this questionnaire. Your cooperation is appreciated.

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98105

tment of Civil Engineering

QUESTIONNAIRE

"Seattle Center Parking Garage and Monorail Extension Feasibility Study"

The Seattle Center Parking Garage and Monorail System presently experience little daytime usage, while the downtown area of Seattle is congested during the daytime. As a graduate student in traffic engineering at the University of Washington, I am studying the feasibility of modifying and extending the Monorail to connect directly to the parking garage at the Seattle Center. The idea is to encourage people to park at the Seattle Center and ride the Monorail to work downtown. Modifications proposed include an extension of one rail north along 5th Avenue to provide direct connection of the Monorail to the second or third level of the parking garage.

An important component of this study is the determination of the level of public acceptance and potential usage of the new system. For this purpose, it is cordially requested that you take a few minutes of your time to answer the nine questions on the reverse side of this form. When completed, please fold the questionnaire, place in the pre-addressed envelope provided, and drop in the nearest mailbox.

Eldon C. Schierman
Graduate, Transportation, Materials
and Geoengineering Division
Department of Civil Engineering,
University of Washington

FIGURE C-2

t were possible to provide a direct, non-stop, 3-minute ride from the tle Center Parking Garage to the downtown Monorail terminal, would be willing to park your car at the Seattle Center Garage and ride the rail to work? (If your answer is "No", please indicate your reason on line below, and then skip directly to [Note A]). Yes_______ No_______

[____]

is the maximum that you would be willing to pay to park your car all day (7 a.m.-m.) at the Seattle Center garage and ride the Monorail to work downtown. (Assume Monorail fare is included as a portion of the parking ticket charge.)

(Please indicate a Daily or a Monthly rate) Maximum Rate per Day_______ or Maximum Rate per Month_______

The Seattle Transit Company presently is operating an all-day "park-and-ride" parking lot near the Seattle Center. The lot is located on 5th Avenue, across from the High School Memorial Stadium. The total charge is 50¢ per day, which pays for parking your car and, also, for bus fare to and from your work downtown. Regular bus routes stop on 5th Avenue next to the lot and are frequently available (every 5 or 6 minutes) during the morning and evening rush periods.

you aware that this "park-and-ride" parking lot is in operation at the tle Center? Yes_______ No_______

yes", have you ever parked your car there and taken the bus to work? Yes_______ No_______

often (in work days per month) do you use the "park-and-ride" parking service?

Parking Rate_______
(days per month)
Never Use _______

is the purpose of your trip downtown today? Work_______ Other_______

long (in minutes) does your normal home-to-work trip take from the time you leave home until you reach the building of your place of work?

Minutes_______

is the Zip Code of your home address? _______

is the name and/or street address of your place of work?

e)____

ress)____
Zip Code

ave any further comments, please list them in the space provided below.

____

____

u for taking your time in filling out this questionnaire. Your cooperation is appreciated.

area as the proposed idea. It was felt necessary to investigate any relationship which might exist between how Question # 1 was answered and whether or not an individual had used before, or even knew about, Seattle Transit's system.

Question # 6 was designed to segregate the returns of employees in the downtown area from those of individuals who were in the CBD for other reasons. Question # 8 identified zip code origins so as to identify those people commuting from the north. The last question, # 9, identifies the location of employment so as to identify those individuals who actually work in the assumed area of study. The responses to the three questions listed above allowed, of course, the identification of those returns which fully satisfied the three basic assumptions of this study that were listed in Chapter II.

The major factor which confounded the distribution of the survey questionnaire was the need to reach employees in the area as compared to shoppers, sight-seers, etc. A workable method was finally devised by locating and identifying major parking facilities in and around the CBD study area. It was assumed that the greatest majority of people who parked in these facilities early in the morning (7:30 - 9:30 AM) were employeees who worked in the vicinity. Figure C-3 shows the locations and arbitrarily assigned identity numbers of all of the parking garage locations where questionnaires were distributed. Table C-I lists the specific garages, their location code numbers, the number of forms distributed, the number of forms returned, and percentage return from each specific garage.

Actual questionnaire distribution was accomplished by stapling a pre-addressed return envelope to the forms and then handing them out during the morning hours specified to individuals emerging from parking garages and

Monorail Feasibity Study

Downtown Survey Questionnaire Distribution Locations

Eldon C. Schierman October 9, 1971

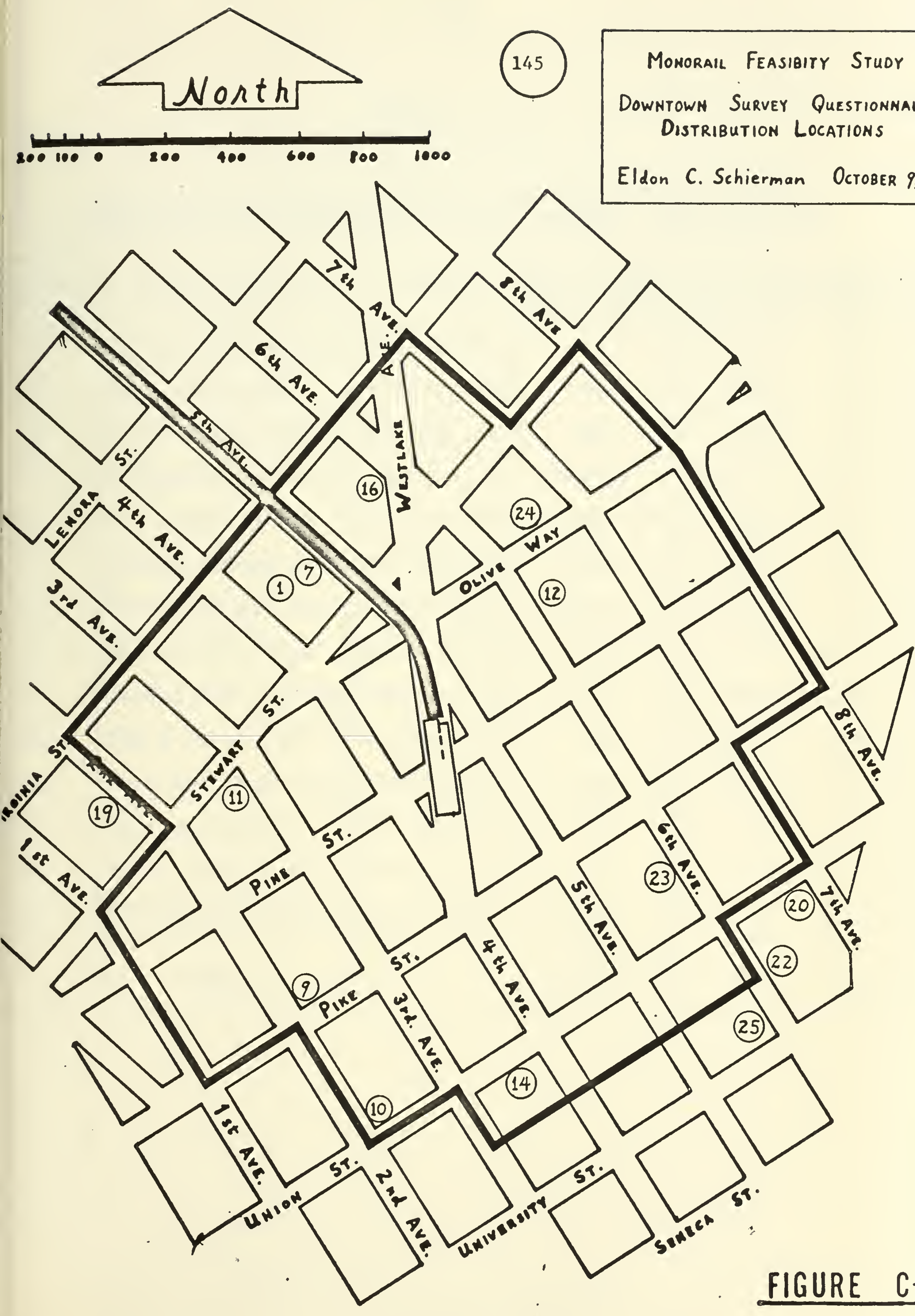


FIGURE C-3

TABLE C-1

SUMMARY OF MONORAIL EXTENSION FEASIBILITY STUDY SURVEY:
QUESTIONNAIRE DISTRIBUTION TOTALS, RETURNS, AND LOCATIONS

ocation Code #	Name Of Parking Location	Address	# Of Forms Distributed	# Of Forms Returned	Percent Return
1.	Centennial Garage	1910½ 4th Av	45	12	26.7%
7.	Avis Rent-A-Car	1911 5th Ave	74	27	36.5%
9.	2nd & Pike Parking	200 Pike St	94	40	42.6%
10.	2nd&Union Parkade	1400 2nd Ave	192	96	50.0%
11.	Self Parking Gar.	1619 3rd Ave	375	83	22.1%
12.	System Garage Co.	601 Olive Wa	150	32	21.3%
14.	Wash.Bldg.Gar.Inc.	315 Union St	247	82	33.2%
16.	Wash.Plaza Hotel	6th & Westlk	115	43	37.4%
19.	Second Ave. Garage	1915 2nd Ave	130	79	60.8%
20.	7th & Union Chev.	623 Union St	70	46	65.8%
22.	Wash.Ath.Club Gar.	1318 6th Ave	30	16	53.3%
23.	Windsor Garage	1415 6th Ave	60	29	48.3%
24.	Vance Parking Gar.	600 Olive Wa	54	29	53.7%
25.	Hilton Hotel Gar.	6th & Univ.	102	18	17.7%
	TOTAL:		1738	638	36.4%

structures. Since these individuals are generally in a hurry to their offices or place of employment, it was intended that they take the form with them, answer the questions later at their own leisure, and return the questionnaire by means of the attached envelope. As can be seen from Table C-I, the total return of the survey was 36.4%, which is just about what is expected for a mailer type survey.

The returned forms were sifted and categorized based on the three basic attraction assumptions discussed earlier. A final sample of 286 forms was arrived at and the resulting data tabulated for analysis. A computer program was authored with the assistance of the Urban Data Center, University of Washington, which tabulated the responses to the various questions. Figure C-4 is the printed computer output of the program. Pictorial representation of the data tabulated in Figure C-4 is shown in figures contained in Chapter II and Appendix B. Of final interest is Table C-II, which tabulates the response to Question # 1 of the questionnaire for the entire survey return as a function of distribution (parking garage) location and, also, of any applicable disqualifying characteristics.

STATISTICAL ANALYSIS OF SURVEY

For purposes of statistical analysis, it is assumed that the distribution of the survey results closely fits a binomial distribution. First of all the population is a large batch of similar items (approximately 4900 employees who work downtown). Secondly, the sample is a relatively small portion of the total population (286-16.5%) which is drawn randomly. Random sampling was not exactly achieved in this case, for practical limitations of questionnaire distribution restricted somewhat the number of people who were

QUESTION 1 YES - 87 PERCENT YES - 31.07 NO - 193 PERCENT NO - 68.92 NO COMMENT - 6

REASON FOR &NO& ANSWER TO QUESTION 1

18 - NO COMMENT
13 - PRESENT GARAGE MORE CONVENIENTLY LOCATED
12 - EMPLOYER PROVIDES CAR AND/OR PARKING
25 - MORE CONVENIENT TO DRIVE DOWNTOWN
86 - USE CAR DURING WORKING DAY
5 - OTHER EXISTING FORMS OF TRANSIT MORE CONVENIENT
5 - REQUIRE NIGHT-TIME AND WEEKEND PARKING
4 - NORMALLY DONT DRIVE TO WORK
16 - PRESENT PARKING AND DRIVING TIME AND COSTS LESS THAN THOSE ANTICIPATED FOR SEATTLE CENTER PARKING
9 - POOR ACCESS BETWEEN SEATTLE CENTER AND I-5

NUMBER WILLING TO PAY GREATER THAN -

$ 0.50	82	$15.50	43
$ 1.00	82	$16.00	43
$ 1.50	82	$16.50	43
$ 2.00	82	$17.00	43
$ 2.50	82	$17.50	42
$ 3.00	82	$18.00	41
$ 3.50	82	$18.50	41
$ 4.00	82	$19.00	41
$ 4.50	82	$19.50	41
$ 5.00	82	$20.00	19
$ 5.50	82	$20.50	19
$ 6.00	81	$21.00	19
$ 6.50	81	$21.50	19
$ 7.00	81	$22.00	19
$ 7.50	81	$22.50	19
$ 8.00	81	$23.00	19
$ 8.50	81	$23.50	19
$ 9.00	81	$24.00	18
$ 9.50	81	$24.50	18
$10.00	67	$25.00	11
$10.50	67	$25.50	11
$11.00	66	$26.00	11
$11.50	66	$26.50	11
$12.00	60	$27.00	10
$12.50	58	$27.50	10
$13.00	58	$28.00	9
$13.50	58	$28.50	9
$14.00	57	$29.00	9
$14.50	57	$29.50	9
$15.00	43	$30.00	2

NO ANSWER TO QUESTION 2 --
FROM THOSE ANSWERING YES TO QUESTION 1- 5
FROM THOSE ANSWERING NO TO QUESTION 1- 193
FROM THOSE NOT ANSWERING QUESTION 1- 6

QUESTION 3 - THOSE ANSWERING YES TO QUESTION 1
YES - 44 PERCENT YES - 50.57 NO - 43 PERCENT NO - 49.42 NO ANSWER - 0

ZIP CODE	EMPLOY. TRIPS	(TOTAL EMPLOY. TRIPS	MEAN TIME HOME-CBD (MINUTES)	MOST PROBABLE ROUTE TO CBD	RESPONSE TO QUEST. 1 YES	NO	NO COMMENT
98002	1	0.34	35.0		1	0	0
98004	3	1.04	18.3		1	1	1
98011	9	3.14	39.0		5	4	0
98020	10	3.49	28.5		3	7	0
98033	13	4.54	34.3		4	9	0
98036	7	2.44	30.7		3	4	0
98039	1	0.34	20.0		1	0	0
98043	4	1.39	33.7		3	1	0
98052	5	1.74	26.0		1	3	1
98072	1	0.34	35.0		0	1	0
98101	2	0.69	22.5		0	2	0
98102	30	10.48	12.2		7	22	1
98103	13	4.54	17.2		3	10	0
98105	18	6.29	17.8		5	13	0
98107	14	4.89	19.3		3	10	1
98109	11	3.84	13.5		6	5	0
98115	42	14.68	18.6		10	32	0
98119	13	4.54	13.8		6	7	0
98122	5	1.74	16.0		0	5	0
98125	8	2.79	17.1		1	6	1
98133	15	5.24	25.5		2	13	0
98155	14	4.89	27.2		4	10	0
98177	14	4.89	29.3		5	9	0
98199	28	9.79	16.5		10	17	1
98201	5	1.74	43.0		3	2	0

DISTANCE FROM CAR TO WORK — RESPONSE TO QUEST. 1

DISTANCE	NO.	PERCENT	YES	NO	NO COMMENT
1- 100 FT	286	100.00	87(100)	193	6
101- 200 FT	228	79.72	73([illegible])	149	6
201- 300 FT	214	74.82	67(77.01)	141	6
301- 400 FT	191	66.78	57([illegible])	128	6
401- 500 FT	149	52.09	46(52.87)	99	4
501- 600 FT	122	42.65	33(37.93)	85	4
601- 700 FT	80	27.97	23(26.44)	56	1
701- 800 FT	59	20.62	19([illegible])	40	0
801- 900 FT	52	18.18	14(16.09)	38	0
901-1000 FT	36	12.58	8(9.20)	28	0
1001-1100 FT	21	7.34	5(5.75)	16	0
1101-1200 FT	17	5.94	5(5.75)	12	0
1201-1300 FT	10	3.49	5(5.75)	5	0
1301-1400 FT	9	3.14	5(5.75)	4	0
1401-1500 FT	5	1.74	1(1.15)	4	0
1501-1600 FT	4	1.39	1(1.15)	3	0
1601-1700 FT	3	1.04	0	3	0
1701-1800 FT	3	1.04	0	3	0
1801-1900 FT	1	0.34	0	1	0
1901-2000 FT	1	0.34	0	1	0

DISTANCE FROM MONORAIL TO WORK — RESPONSE TO QUEST. 1

DISTANCE	NO.	PERCENT	YES	NO	NO COMMENT
1- 100 FT	286	100.00	87(100)	193	6
101- 200 FT	285	99.65	87([illegible])	192	6
201- 300 FT	280	97.90	83(95.40)	191	6
301- 400 FT	251	87.76	73([illegible])	173	5
401- 500 FT	246	86.01	73([illegible])	168	5
501- 600 FT	222	77.62	64([illegible])	155	3
601- 700 FT	208	72.72	62(71.26)	144	2
701- 800 FT	181	63.28	53(60.92)	126	2
801- 900 FT	150	52.44	45(51.72)	104	1
901-1000 FT	120	41.95	32(36.78)	87	1
1001-1100 FT	17	5.94	7(8.05)	9	1
1101-1200 FT	1	0.34	0	1	0
1201-1300 FT	0	0.00	0	0	0
1301-1400 FT	0	0.00	0	0	0
1401-1500 FT	0	0.00	0	0	0
1501-1600 FT	0	0.00	0	0	0
1601-1700 FT	0	0.00	0	0	0
1701-1800 FT	0	0.00	0	0	0
1801-1900 FT	0	0.00	0	0	0
1901-2000 FT	0	0.00	0	0	0

TABLE C-II

SUMMARY OF RESPONSE TO MONORAIL EXTENSION IDEA AS A FUNCTION OF QUESTIONNAIRE DISTRIBUTION LOCATION

Survey Questionnaire Distribution Location Code Number:

	# 1	# 7	# 9	#10	#11	#12	#14	#16	#19	#20	#22	#23	#24	#25
From Sample Satisfying All Basic Assumptions:														
Yes	2	3	6	10	9	9	9	3	11	11	1	6	5	1
No	7	8	13	32	27	7	22	10	24	17	6	9	9	3
No Comment	0	4	1	0	0	0	0	0	1	0	1	0	0	0
Total:	9	15	20	42	36	16	31	13	36	28	8	15	14	4
Those Parking For Other Than Work Trip:														
Yes	0	0	0	0	4	5	4	0	2	1	0	1	0	0
No	0	0	2	0	11	2	6	8	1	2	1	1	0	1
No Comment	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Total:	0	0	2	0	15	8	11	8	3	3	1	2	0	1
Those Who Live On South End Of Town, Or In Bellvue And Use The Mercer Island Bridge:														
Yes	0	0	2	4	4	0	8	1	2	2	0	0	2	2
No	1	9	9	26	16	5	11	7	22	6	3	6	5	4
No Comment	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Total:	1	9	11	30	20	5	20	8	24	8	4	6	7	6
Those Who Come From North But Work Out Of Study Area:														
Yes	0	0	0	2	3	1	3	2	2	0	0	0	0	1
No	0	1	1	8	4	0	6	7	11	1	0	2	0	5
No Comment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	0	1	1	10	7	1	9	9	13	1	0	2	0	6
Those Who Live In Belvue, Unknown Route To CBD:														
Yes	1	0	0	1	1	1	2	0	1	1	0	0	1	0
No	0	2	4	10	3	0	5	4	1	2	3	2	7	1
No Comment	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	1	2	4	11	4	1	7	4	2	3	3	2	8	1
Unknown Information, Incomplete Responses, Unable To Analyze:														
Yes	0	0	0	0	1	0	1	1	0	1	0	0	0	0
No	1	0	2	3	0	0	2	0	1	2	0	1	0	0
No Comment	0	0	0	0	0	1	1	0	0	0	0	1	0	0
Total:	1	0	2	3	1	1	4	1	1	3	0	2	0	0
TOTAL:	12	27	40	96	83	32	82	43	79	46	16	29	29	18

Total Forms Distributed - 1738

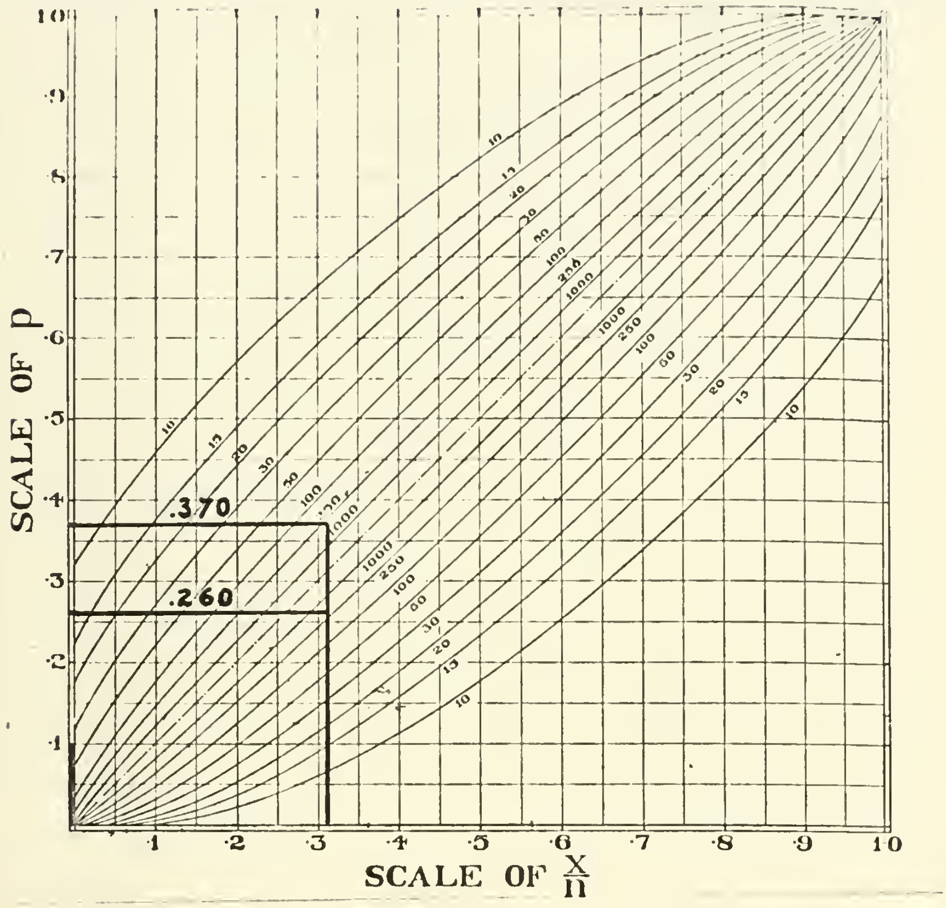
Total Forms Returned - 632

Percent Return - 36.4%

approached for sampling. Finally, the "outcome" of the survey has only two possibilities, namely, "yes" or "no." Satisfaction of these criteria indicate that the downtown employee acceptance of the Monorail extension proposal is closely approximated by the binomial distribution.

Of final interest is the establishment of distribution intervals for the total survey population. As indicated in the discussion of Chapter II, 31.07% of the survey sample indicated "yes" on their questionnaires. Of upmost importance is the question of how well this sample represents the actual distribution of the total population. Figures C-5 and C-6 are sets of curves that can be used to determine confidence intervals for the binomial distribution at confidence levels of 95% and 99% respectively. The figures are entered with an X (number of "yes" responses) over n (total sample size) figure of 0.3107. A vertical line is drawn to intersect the sample size (286) curves and then carried over at right angles to the p-axis where p is the proportion of "yes" responses in the total population. A confidence interval is thus determined for a given level of confidence. What is meant is that for a stated level of confidence, it can be said that the total population value of p actually lies somewhere within the given limits. From Figure C-5, it is evident that with 95% confidence we can state that the actual number of "yes" responses within the total employment population is somewhere between 26.0% and 37.0%. With 99% confidence, however, it can be said only that the actual value of p is somewhere between 24.6% and 38.4%.

CONFIDENCE BELTS FOR p (CONFIDENCE COEFFICIENT ·95)

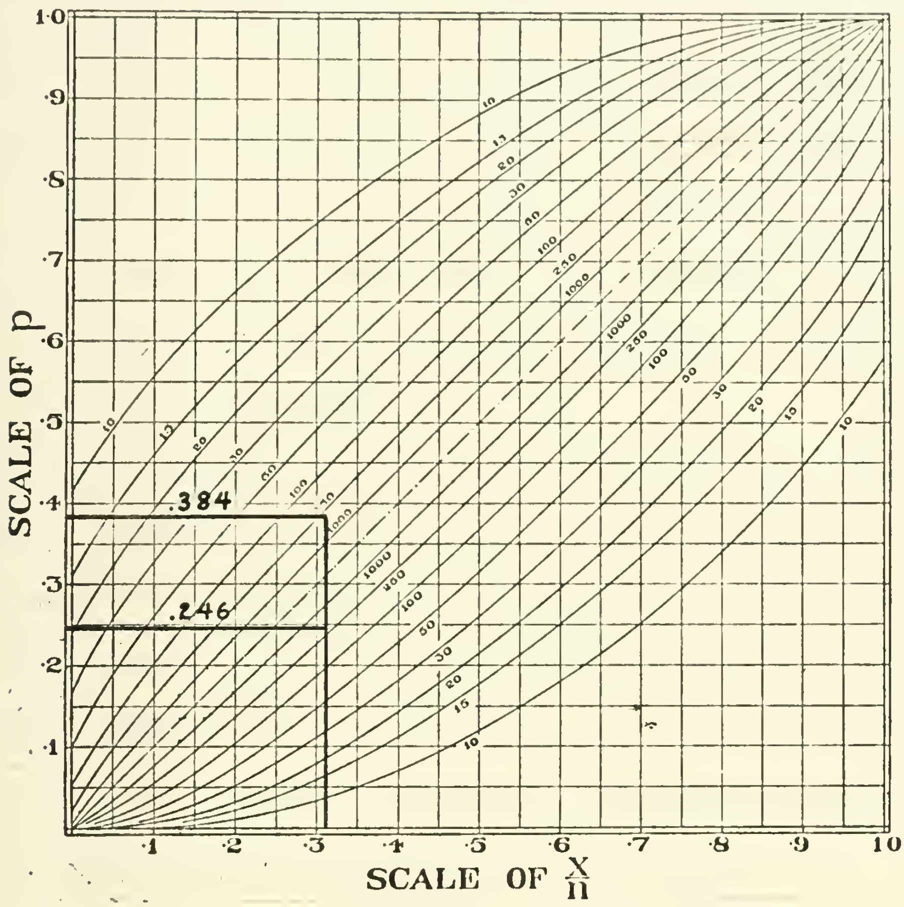


95 PERCENT CONFIDENCE INTERVALS - BINOMIAL DISTRIBUTION

(From A Paper By C. Clopper and E. Pearson, "The Use Of Confidence Or Fiducial Limits Illustrated In The Case Of The Binomial", Biometrika, vol.26 (1934))

FIGURE C-5

CONFIDENCE BELTS FOR p (CONFIDENCE COEFFICIENT ·99)



99 PERCENT CONFIDENCE INTERVALS - BINOMIAL DISTRIBUTION

(From A Paper By C. Clopper and E. Pearson, "The Use Of Confidence Or Fiducial Limits Illustrated In The Case Of The Binomial", Biometrika, vol.26 (1934))

FIGURE C-6

APPENDIX D

In this section sketches are presented detailing a proposed passenger terminal for a Monorail extension to the Seattle Center Parking Structure. The terminal is elevated along the south face of the Garage with the passenger loading/unloading platform extending out from the second parking level. A passenger undercrossing is suspended beneath the elevated main platforms. This allows access from street level, the first parking level, and, also, between the platforms themselves. Figures D-7, D-8, and D-9 show three views of the underpass.

The terminal structure is patterned after the existing terminal at the Seattle Center. A structural analysis if the proposed design is not included in this study, however, since an existing structure is used as a pattern, it is felt that the design probably is structurally satisfactory. It is recommended that any further study of the Monorail extension proposal presented in this report include a detailed engineering structural analysis of the terminal in order to refine the design and cost estimates.

Table D-I tabulates the cost estimates for all aspects of the terminal construction, less the three main supporting "T" columns. Each construction phase is listed with unit prices, estimated amounts of material, and total costs. The final cost estimate of $955,000.00 for the entire Monorail Extension project is given on the last page of the table.

SECTION A-A (LOOKING NORTH)

1/16" = 1'-0"

Parking Structure Longitudinal & Transverse Sections (Looking North)

Scale: 1/16" = 1'

Eldon C Schierman — October 9, 1971

FIGURE D-1

KIRK, WALLACE, McKINLEY, A.I.A. & ASSOCIATES, ARCHITECTS 000 FAIRVIEW AVENUE EAST SEATTLE 2, WASHINGTON • EAst 4-2364	REGISTERED ARCHITECT PAUL HAYDEN KIRK STATE OF WASHINGTON	NORMAN G. JACOBSON, JR. & ASSOCIATES CONSULTING ENGINEERS 11728 AURORA AVENUE — SEATTLE 33, WASHINGTON — EMerson 3-6900	NORMAN G. JACOBSON, JR. STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

APPROVED BY ATTEST 8-1-1961	SEATTLE CENTER 1500 CAR SELF-PARKING FACILITY & PEDESTRIAN OVERPASS NOB HILL AVE. & MERCER ST. — SEATTLE, WASH.	A-10
DESIGNED DRAWN	LONGITUDINAL & TRANSVERSE SECTIONS	CHECKED DATE 8/16/61 — 6133

DATE | REV. | DESCRIPTION | APP.

MERCER STREET ELEVATION (SOUTH)
1/16" = 1'-0"

PARKING STRUCTURE EXTERIOR ELEVATIONS
SOUTH FACE (LOOKING NORTH)

SCALE: 1/16" = 1'

Eldon C Schierman October 9, 1971

FIGURE D-2

KIRK, WALLACE, McKINLEY, A.I.A. & ASSOCIATES, ARCHITECTS
2000 FAIRVIEW AVENUE EAST
SEATTLE 2, WASHINGTON • EAst 4-23

REGISTERED ARCHITECT
PAUL HAYDEN KIRK
STATE OF WASHINGTON

NORMAN G. JACOBSON, JR. & ASSOCIATES
CONSULTING ENGINEERS
11728 AURORA AVENUE SEATTLE 33, WASHINGTON EMerson 3-6900

NORMAN G. JACOBSON JR. STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

APPROVED BY
ATTEST 8-16 1961
SECY., BOARD OF PUBLIC WORKS

SEATTLE CENTER
1500 CAR SELF-PARKING FACILITY
& PEDESTRIAN OVERPASS
NOB HILL AVE. & MERCER ST. SEATTLE, WASH.

A-9

DESIGNED
DRAWN

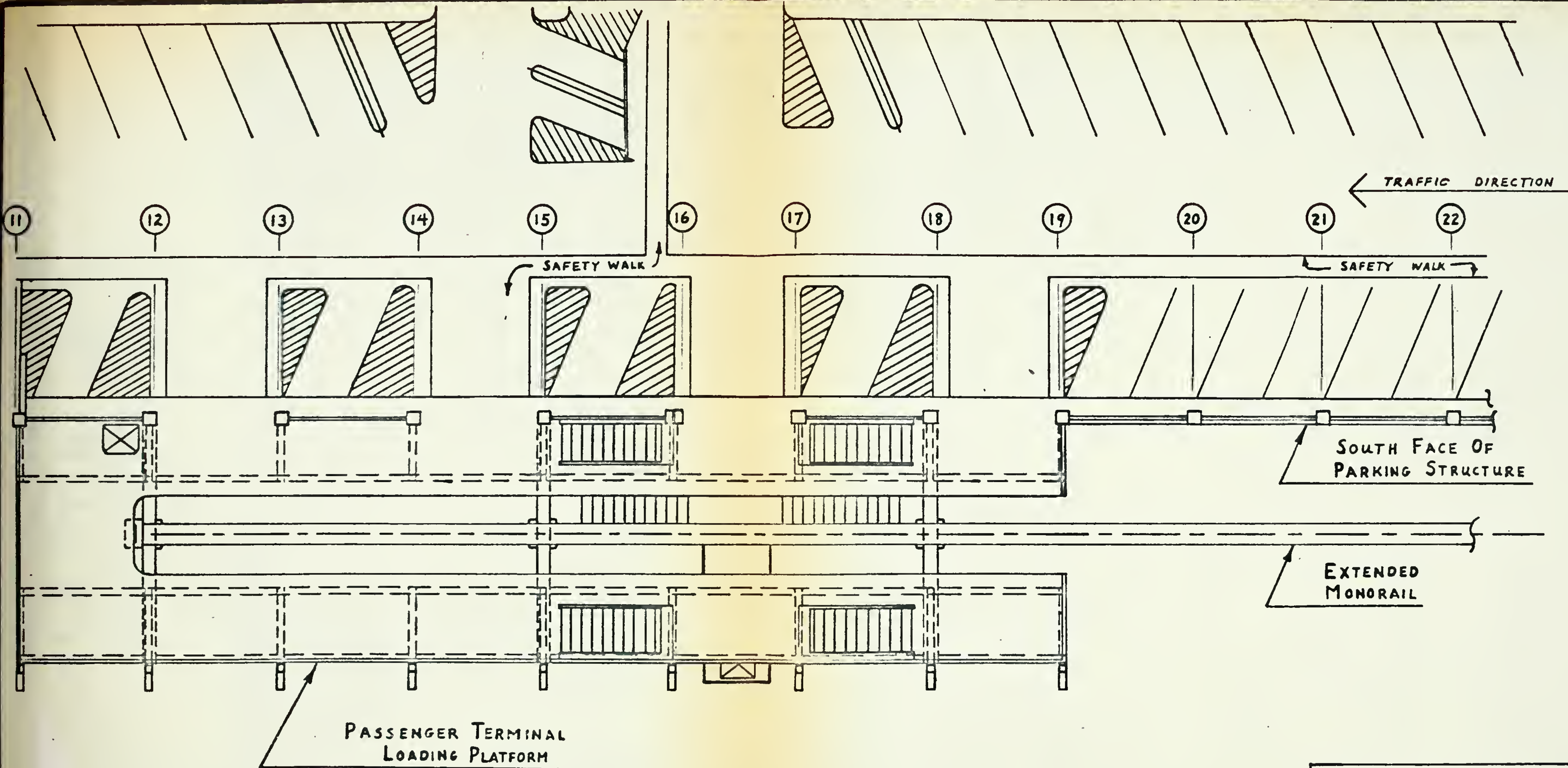
EXTERIOR ELEVATIONS

CHECKED
DATE 8/16/61

6133

DATE | REV. | DESCRIPTION | APP

44-9



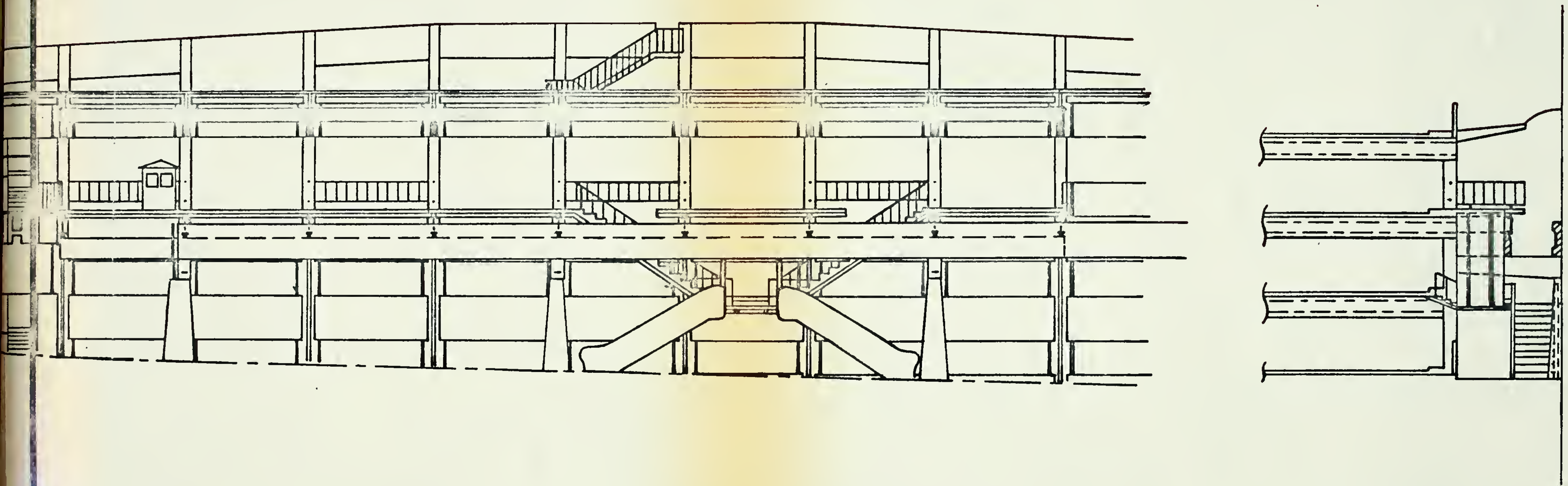
Proposed Monorail Terminal As Attached To South Face Of Parking Structure

PLAN VIEW

Scale: 1/16" = 1'

Eldon C Schierman August 4, 1971

FIGURE D-3



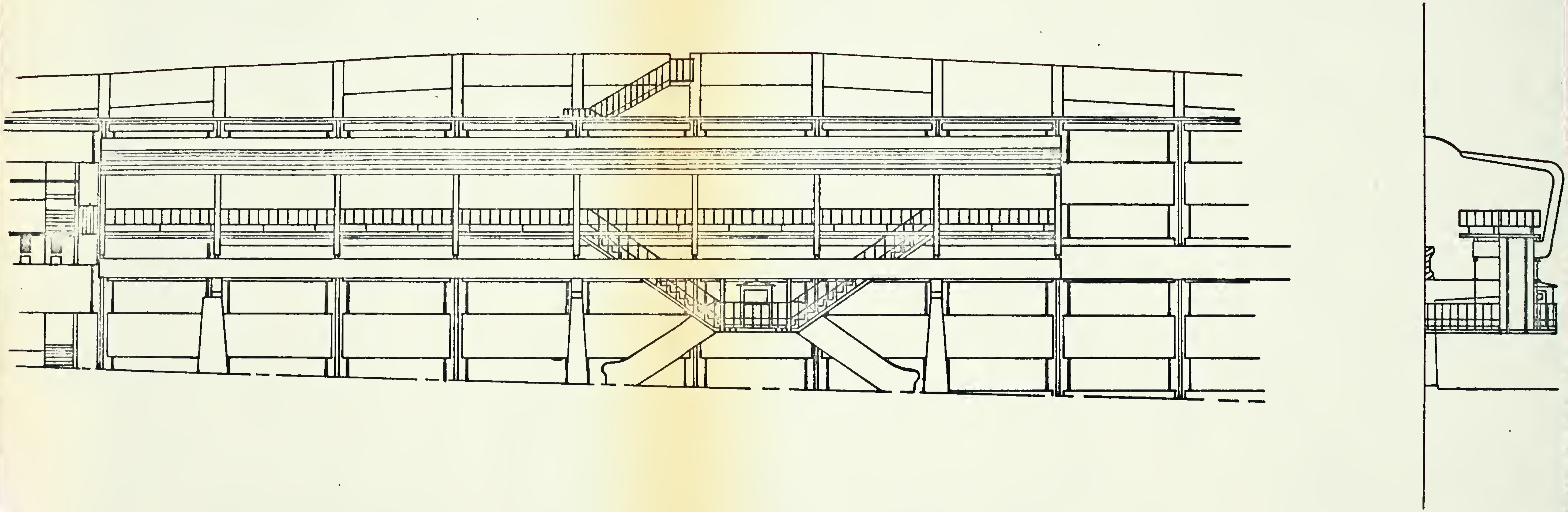
Proposed Monorail Terminal As Attached
To South Face Of Parking Structure

TERMINAL'S NORTHERN HALF (LOOKING NORTH)

Scale: 1/16″ = 1′

Eldon C Schierman August 5, 1971

FIGURE D-4



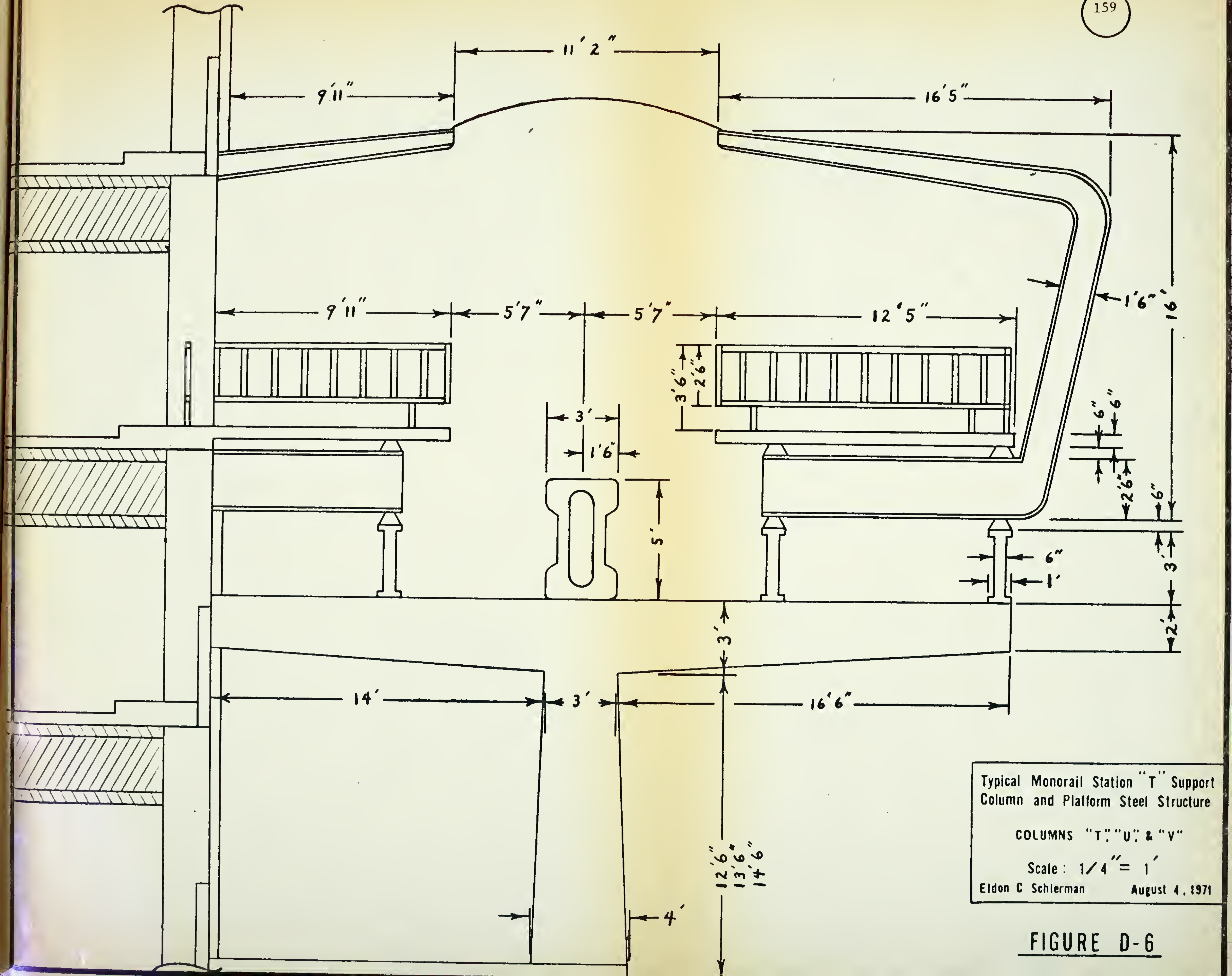
Proposed Monorail Terminal As Attached
To South Face Of Parking Structure

TERMINAL'S SOUTHERN HALF (LOOKING NORTH)

Scale : 1/16" = 1'

Eldon C Schierman August 5, 1971

FIGURE D-5



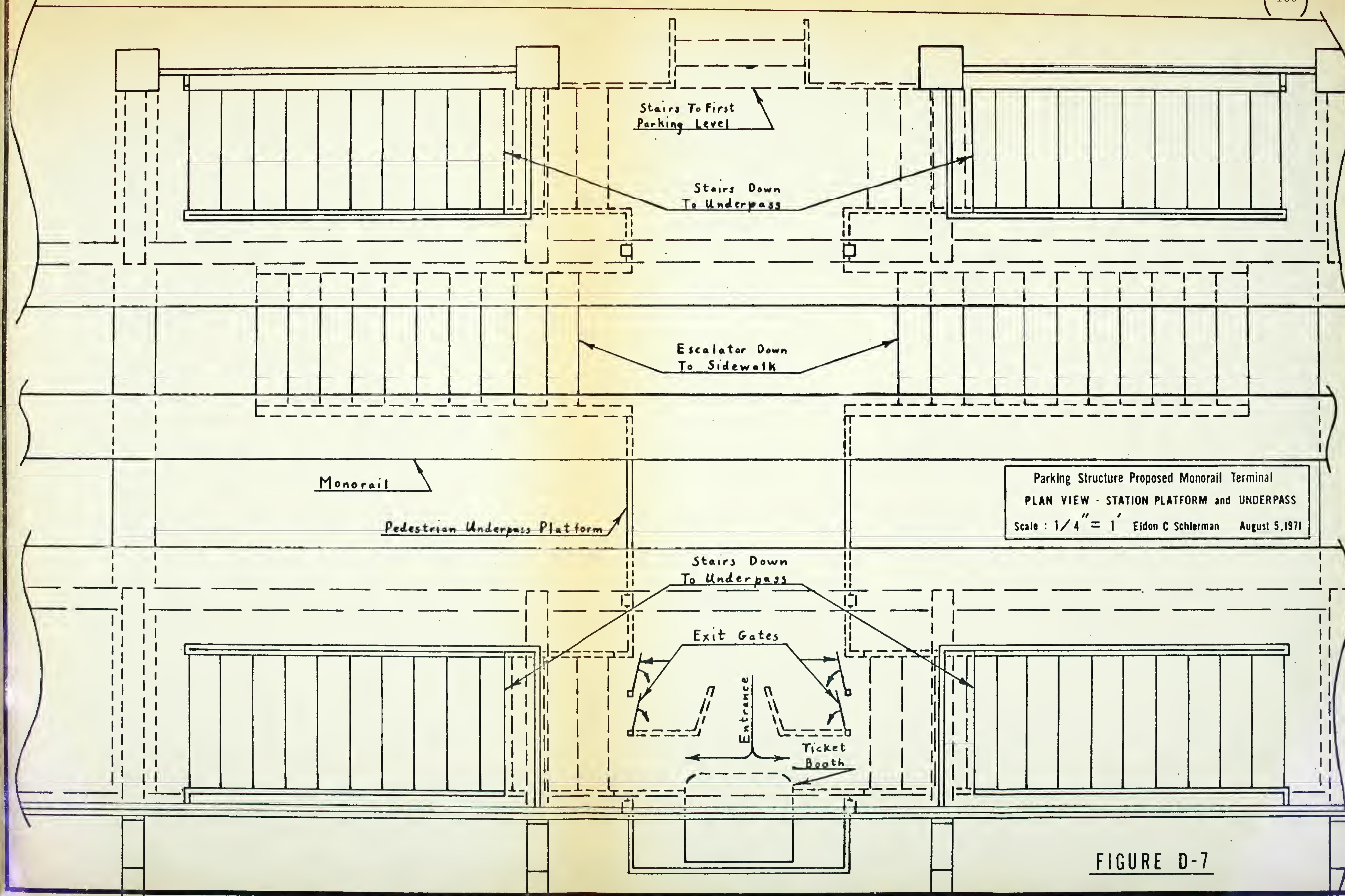
Typical Monorail Station "T" Support Column and Platform Steel Structure

COLUMNS "T", "U", & "V"

Scale: 1/4" = 1'

Eldon C Schierman August 4, 1971

FIGURE D-6



Parking Structure Proposed Monorail Terminal

PLAN VIEW - STATION PLATFORM and UNDERPASS

Scale : 1/4" = 1' Eldon C Schlerman August 5, 1971

FIGURE D-7

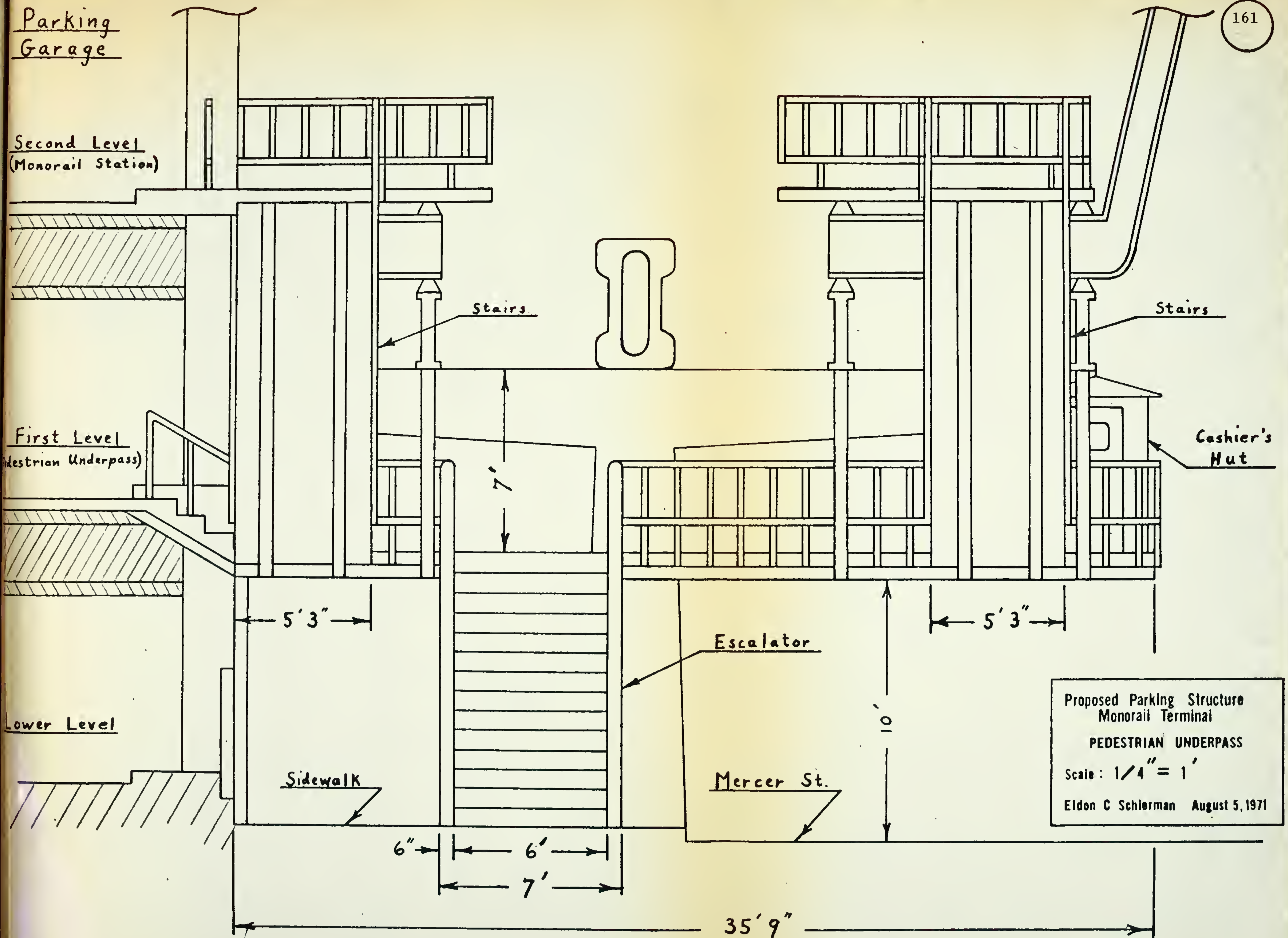
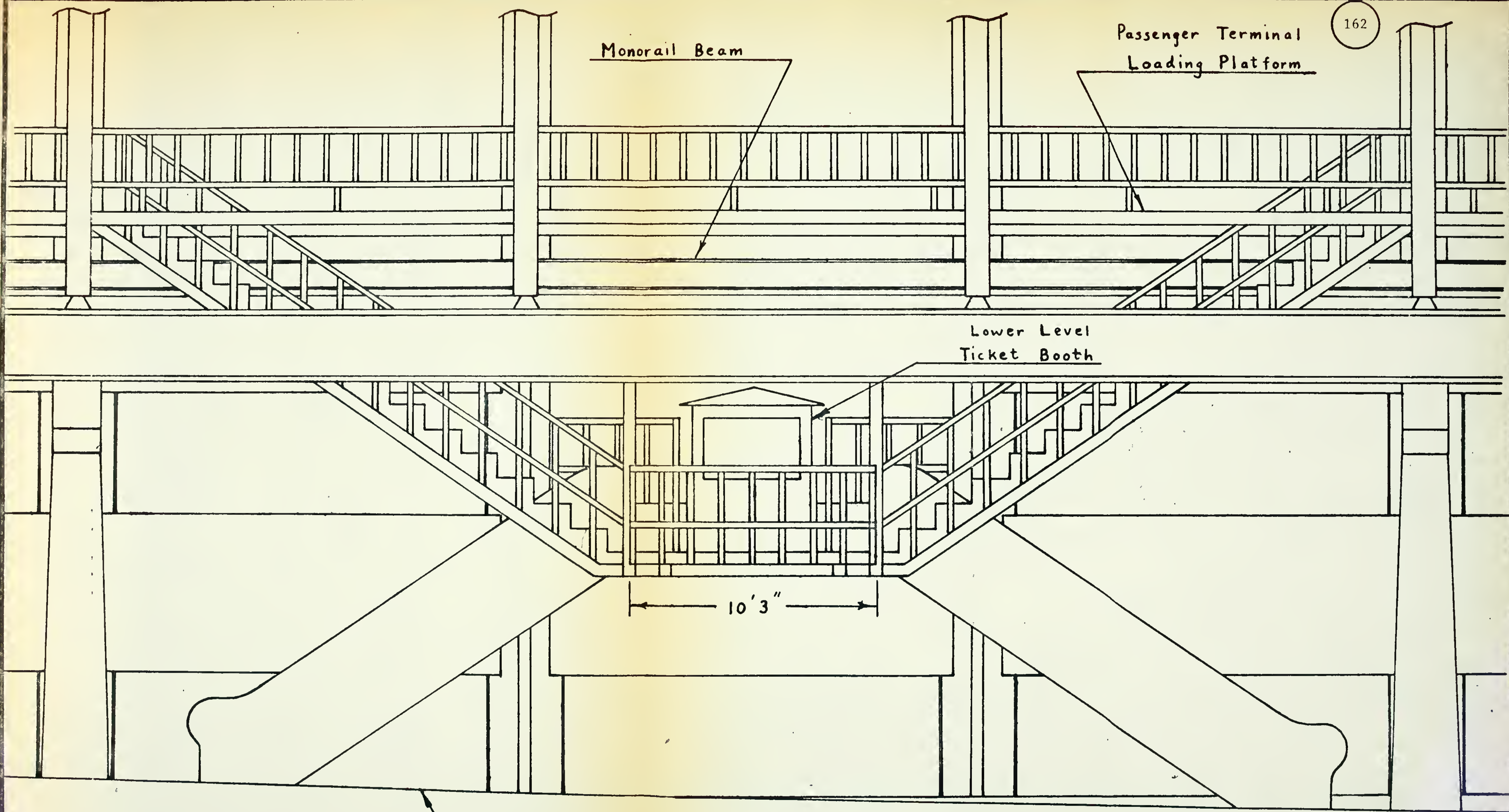

Parking Garage
Second Level
(Monorail Station)
First Level
(Pedestrian Underpass)
Lower Level
Stairs
Stairs
Cashier's Hut
Escalator
Sidewalk
Mercer St.
7'
10'
5'3"
5'3"
6"
6'
7'
35'9"
Proposed Parking Structure
Monorail Terminal
PEDESTRIAN UNDERPASS
Scale: 1/4" = 1'
Eldon C Schierman August 5, 1971

FIGURE D-8



Parking Structure Proposed Monorail Terminal
END VIEW - STATION PLATFORM and UNDERPASS
Scale : 1/4" = 1' Eldon C Schierman August 5, 1971

FIGURE D-9

TABLE D-I(a)

CAPITAL COST ESTIMATES FOR THE PROPOSED MONORAIL EXTENSION

FOOTINGS:

I. Type "1" - Driven-Pile Foundation (see Figure 38)

A. Average Foundation Specifications
1. Four (4) BP 12 "H" Piles
2. Each Pile 50ft In Length
3. 10'x 10'x 5' Reinforced Concrete Cap

B. Cost Breakdown Per Footing
1. Steel Piles (@ $0.13/lb) - $ 2000.00
2. Pile Driving (4 piles) - 400.00
3. Excavation (10'x 14'x 14' = 73cu yds)- 200.00
4. Shoring (@ $3.00/sq ft) - 1700.00
5. Reinforced Concrete Cap
a. Volume - 18.5 cu yds
b. Unit Price - $160 / cu yd
c. Cost - 3000.00

C. Total Cost Per Footing - $ 7300.00

II. Type "2" - Cast-In-Place Pier Foundation (see Figure 37)

A. Average Foundation Specifications
1. Average Height - 21.0 ft
2. Average Volume - 23 cu yds

B. Cost Breakdown Per Footing
1. Concrete and Re-bar (@ $160/cu yd) - $ 3700.00
2. Excavation (25'x 16'x 16' =237cu yds)- 300.00
3. Shoring (@ $3.00/sq ft) - 4800.00

C. Total Cost Per Footing - $ 8800.00

III. Assumed Average Cost Per Footing - $ 8000.00/footing
(Except for footings under columns Q, T, U, & V)

A. Applicable Footings: 6A, 7A, A-P, R-S

B. Total Cost For Applicable Footings - $160,000.00

IV. Average Cost Per Footing Under Columns
Q, T, U, and V - $ 10,000.00/footing

A. Total Cost For Applicable Footings - $ 40,000.00

TABLE D-1(b)

V. Sub Total (T1) - $200,000.00

VI. Sales Tax @ 5% (T1 x 0.05) - $ 10,000.00

VII. Overhead And Profit @ 15% (T1 x 0.15) - $ 30,000.00

VIII. Sub Total (T2) - $240,000.00

IX. Excise Tax @ 0.62% of contract (T2x0.0062) - $ 1,400.00

X. TOTAL COST (Of Footings) - $241,400.00

CAST-IN-PLACE MONORAIL BEAM SUPPORT PEDESTALS:

I. Type "A" Columns (see Figure 37)

A. Average Pedestal Specifications
1. Applicable Columns - Columns A-S, less column Q
2. Over-all Height (including 4ft below ground level) - 27.35 ft
3. Volume - 15 cu yds
4. Unit Price For Construction and Finish - $ 2400.00/column

B. Total Cost For Applicable Columns - $ 43,200.00

II. Type "B" T - Columns (see Figure D- 6)

A. Average Pedestal Specifications
1. Applicable Columns - Columns T, U, and V

B. Column T
1. Volume - 20.3 cu yds
2. Unit Price For Construction and Finish - $160 / cu yd
3. Construction Cost (in place) - $ 3312.00

C. Column U
1. Volume - 24.6 cu yds
2. Unit Price For Construction and Finish - $160 / cu yd
3. Construction Cost (in place) - $ 3248.00

TABLE D-I(c)

D. Column V
1. Volume - 24.6 cu yds
2. Unit Price For Construction and Finish - $160 / cu yd
3. Construction Cost (in place) - $ 3936.00

III. Column 6A (Plus Connecting Cross-Member) - $ 5000.00

IV. Column 7A (Plus Connecting Cross-Member) - $ 4000.00

V. Column Q (See Figure 38)

A. Average Pedestal Specifications
1. WF Structural Steel @ 700 lbs per foot
2. Total Length - 70 ft
3. Total Weight - 49,000 lbs
4. Plus 10% For Connections & Waste - 4900 lbs
5. Total Adjusted Weight - 53,900 lbs
6. Unit Price (in place) - $ 0.40/lb

B. Total Cost For Column Q - $ 21,560.00

VI. Sub Total (T1) - $ 84,256.00

VII. Sales Tax @ 5% (T1 x 0.05) - $ 4210.00

VIII. Overhead And Profit @ 15% (T1 x 0.15) - $ 12,634.00

IX. Sub Total (T2) - $101,100.00

X. Excise Tax @ 0.62% of contract (T2x0.0062) - $ 600.00

XI. TOTAL COST (Of Support Pedestals) - $101,700.00

MONORAIL BEAM EXTENSION:

I. Forms - One Unit Required For Both Straight & Curved Sections

A. Unit Cost - $ 60,000.00

TABLE D-I(d)

II. Beam Manufacture

A. Unit Price (For Manufacture Only) - $ 75.00/foot

B. Total Length Of Beam Extension - 1858 feet

C. Total Beam Manufacture Cost - $139,350.00

III. Shipping Costs

A. Assume that the beams are cast on the construction sight and that no additional shipping is required.

IV. Beam Installation

A. Total Installation Cost Per Beam (Includes Cost Of Crane) - $ 225.00/beam

B. Number Of Applicable Beams - 22

C. Total Beam Installation Cost - $ 5000.00

V. Miscellaneous Expenses

A. Expansion Joint Plates / Beam Mounting Pads And Connections - $ 5000.00

B. Power And Controller Bar - $ 5000.00

VI. Sub Total (T1) - $214,350.00

VII. Sales Tax @ 5% (T1 x 0.05) - $ 10,708.00

VIII. Overhead And Profit @ 15% (T1 x).15) - $ 32,142.00

IX. Sut Total (T2) - $257,200.00

X. Excise Tax @ 0.62% of contract (T2x0.0062) - $ 1,600.00

XI. TOTAL COST (Of Monorail Beam) - $258,800.00

TABLE D-I(e)

MONORAIL BEAM SWITCHING:

I. Assume A Straight Beam Switch, Hinged On One End At Column # 8. Switch Would Span From Column # 6A To # 8.

II.	Length Of Switch Beam	-	90 ft
III.	Unit Cost (Includes Operating Mechanism And Controllers)	-	$ 375.00/ft
IV.	Sub Total (T1)	-	$ 33,750.00
V.	Sales Tax @ 5% (T1 x 0.05)	-	$ 1,687.00
VI.	Overhead And Profit @ 15% (T1 x 0.15)	-	$ 5,062.50
VII.	Sub Total (T2)	-	$ 40,500.00
VIII.	Excise Tax @ 0.625 of contract (T2x0.0062)	-	$ 200.00
IX.	TOTAL COST (Of Monorail Beam Switch)	-	$ 40,700.00

NEW MONORAIL TERMINAL (LESS COLUMNS T, U, & V):

I. Standard Structural Steel

A. 36 WF 160 (36" x 12")

1.	Unit Weight	-	160 lb/ft
2.	Total Length (3 Pieces, 148.5' ea)	-	445.5 ft
3.	Total Weight	-	71,280 lbs

B. 30 WF 116 (30" x 10.5")

1.	Unit Weight	-	116 lb/ft
2.	Total Length (9 Pieces, 8' ea)	-	72 ft
3.	Total Weight	-	8,352 lbs

C.	Total Weight	-	79,632 lbs
D.	Plus 10% For Connections And Waste	-	7,963 lbs

TABLE D-I(f)

E. Total Adjusted Weight - 43.79 tons or 87,595 lbs

F. Unit Price (In Place) - $ 550.00/ton

G. Total Cost (Standard Structural Steel) - $ 24,084.00

II. Miscellaneous Steel, Heavy

A. Garage-Side Roof Girders
   1. Nominal 14 WF 43 (14" x 8")
      a. Unit Weight 43 lb/ft
      b. Total Length (9 pieces, 10' ea) - 90 ft
      c. Total Weight - 3870 lbs

B. Special "U" Platform / Roof Supports
   1. Unit Weight - 2664 lbs/member
   2. Total Weight (9 pieces) - 23,976 lbs

C. Total Weight - 27,846 lbs

D. Plus 10% For Connections And Waste - 2,785 lbs

E. Total Adjusted Weight - 30,631 lbs

F. Unit Price (In Place) - $ 0.40/lb

G. Total Cost (Misc. Heavy Steel) - $ 12,252.00

III. Miscellaneous Steel, Hollow Tube Architectural Railing

A. Total Length - 525 ft

B. Unit Price - $ 15.00/ft

C. Total Cost (In Place) - $ 7875.00

IV. Miscellaneous Steel, Pedestrian Underpass Supports

A. Nominal 4" x 4" Hollow Square Pipe
   1. Total Length - 314 ft
   2. Unit Weight - 15 lb/ft
   3. Total Weight - 4710 lbs
   4. Unit Price (In Place) - $ 0.40/lb
   5. Total Cost - $ 1884.00

B. Nominal 6" x 6" Hollow Square Pipe
   1. Total Length - 48 ft
   2. Unit Weight - 28 lb/ft

TABLE D-1(g)

3. Total Weight	-	1344 lbs
4. Unit Price (In Place)	-	$ 0.40/lb
5. Total Cost	-	$ 537.00

V. Miscellaneous Steel, Imbedded Pads

A. Total Weight	-	1000 lbs
B. Unit Price	-	$ 0.40/lb
C. Total Cost (Imbedded Pads)	-	$ 400.00

VI. Pre-Cast Concrete

A. Platform Slab - 6" thick

1. Total Area	-	3540 sq ft
2. Total Volume	-	65 cu yds
3. Unit Price (In Place)	-	$ 160 / yd
4. Total Cost	-	$ 10,400.00

B. Stair Units - 4 Units

1. Total Volume	-	19.5 cu yds
2. Unit Price (In Place)	-	$ 200 / yd
3. Total Cost	-	$ 3,900.00

VII. Escalators - 2 Units

A. Unit Price (In Place)	-	$32,000/unit
B. Total Cost	-	$ 64,000.00

VIII. Roof Material - Uninsulated, Light Weight

A. Total Area	-	4000 sq ft
C. Unit Price (In Place)	-	$ 0.20/sq ft
D. Total Cost	-	$ 800.00

IX. Plexiglass Skylight

A. Total Area	-	1800 sq ft
B. Unit Price (In Place)	-	$ 5.00/sq ft
C. Total Cost	-	$ 8,000.00

TABLE D-I(h)

X. Painting - 2 Coats		
A. Total Painted Surface	-	9000 sq ft
B. Unit Price (Per Coat)	- $	0.10/sqft
C. Total Cost	- $	1,800.00
XI. Electrical		
A. Total Cost	- $	3,500.00
XII. Plumbing		
A. Roof Drains and Sight Drainage	- $	2.300.00
XIII. Ticket Booths, Pre-fabricated - 2 Units		
A. Unit Price (In Place)	- $	3,000.00
B. Total Cost	- $	6,000.00
XIV. Miscellaneous Alterations - To Existing Garage		
A. Total Cost	- $	5,000.00
XV. Sub Total (T1)	- $	152,732.00
XVI. Sales Tax @ 5% (T1 x 0.05)	- $	7,636.00
XVII. Overhead And Profit @ 15% (T1 x 0.15)	- $	22,908.00
XVIII. Sub Total (T2)	- $	183,276.00
XIX. Excise Tax @ 0.62% of contract (T2x0.0062)	- $	1,130.00
XX. TOTAL COST (NEW MONORAIL TERMINAL)	- $	184,400.00

TABLE D-I(i)

MISCELLANEOUS COSTS:

I. Removal Of Existing Trees - 44 Trees

A. Unit Price - $ 150/tree

B. Total Cost - $ 6,600.00

II. Inatallation Of Bus Bays On Mercer Street

A. Concrete Curb Removal
1. Total Length - 600 ft
2. Unit Price - $ 1.30/ft
3. Total Cost - $ 780.00

B. Asphalt Removal
1. Total Area - 6100 sq ft
2. Unit Price - $ 0.50/sqft
3. Total Cost - $ 3,050.00

C. Concrete Curb Installation
1. Total Length - 1465 ft
2. Unit Price - $ 2.00/ft
3. Total Cost - $ 2,930.00

D. Concrete Island / Sidewalk Installation
1. Total Area - 5000 sq ft
2. Unit Cost - $ 0.70/sqft
3. Total Cost - $ 3,500.00

E. Asphalt Patching - 3" deep
1. Total Area - 144.5sq yds
2. Unit Cost - $ 2.70/sqyd
3. Total Cost - $ 390.00

F. Miscellaneous Painting & Traffic Buttons
1. Total Cost - $ 1,000.00

G. Total Cost (Bus Bays) - $ 11,650.00

III. Removal And Re-installation Of Sidewalk And Street Around Each Footing Excavation

A. Total Cost - $ 10,000.00

IV. Street Light Relocation

TABLE D-I(j)

A. Existing Installations - 15 Units
   1. Removal Unit Price - $ 200/pole
   2. Total Removal Cost - $ 3,000.00

B. New, Re-designed Installations - 15 Units
   1. Installation Unit Price - $ 1,000.00
   2. Total Installation Price - $ 15,000.00

V. Miscallaneous Utility, Fire Hydrant, And Catch Basin Relocation

   A. Total Cost - $ 10,000.00

VI. Signal Re-installation - 3 Units

   A. Unit Price - $ 2500/relocation

   B. Total Cost - $ 7,500.00

VII. Installation Of New Traffic Signs

   A. Total Cost - $ 200.00

VIII. Core Sampling And Soil Analysis

   A. Total Cost - $ 10,000.00

IX. TOTAL COST (MISCELLANEOUS COSTS) - $ 74.000.00

TOTAL CONSTRUCTION COST: - $901,000.00

<u>ARCHITECT AND DESIGN ENGINEERING</u>:

I. 6% Of Total Construction Cost - $ 54,000.00

TOTAL COST OF PROJECT: - $955,000.00

MATERIAL CITED

I 1 I. "Alweg Monorail." The Fascinating Story of the World's Most Modern Transportation System. Seattle, Washington: Alweg Rapid Transit Systems of Washington State, Inc., 1962, page 4.

I 2 I. Ekse, Martin, et al. Seattle Monorail, A Mass Transportation Demonstration Study by the University of Washington Civil Engineering Department. Seattle, Washington: University of Washington, October, 1962, page 1.

I 3 I. Riggs, James L. Economic Decision Models for Engineers and Managers. New York: McGraw-Hill Book Company, 1964, pages 385-388.

SELECTED BIBLIOGRAPHY

"Alweg Monorail." The Fascinating Story of the World's Most Modern Transportation System. Seattle, Washington: Alweg Rapid Transit Systems of Washington State, Inc., 1962.

Clopper, C. and E. Pearson. "The Use of Confidence or Fiducial Limits Illustrated in the Case of the Binomial," Biometrika. Cambridge, Great Britain: University Press, vol. 26, 1934.

Ekse, Martin, et al. Seattle Monorail, A Mass Transportation Demonstration Study by the University of Washington Civil Engineering Department. Seattle, Washington: University of Washington, October, 1962.

Riggs, James L. Economic Decision Models for Engineers and Managers. New York: McGraw-Hill Book Company, 1968.

Roberts, Norman H. Mathematical Methods in Reliability Engineering. New York: McGraw-Hill Book Company, 1964.

Sawhill, Roy B., James H. Matteson, Jerome W. Hall. Course Notes for Solution of Intersection and Highway Capacity. Seattle, Washington: University of Washington, March, 1970.

Schierman, Eldon C. "A Look at the Urban Mass Transportation Act of 1964." Unpublished Term Paper. Seattle, Washington: University of Washington, March, 1971.

Transportation Planning and Engineering, Inc. "City of Seattle - Seattle Center Parking and Traffic Study." Seattle, Washington, September, 1968.

U.S. Government. Northwest Federal Regional Council. January, 1971.

Thesis
S33646 131042
Schierman
An economic feasibility study of extension of the Seattle monorail to connect directly to the Seattle Center parking garage.